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JPL PUBLICATION 78-15, VOLUME XIV

Characterization of Solar Cells for Space Applications

**Volume XIV. Electrical Characteristics of
Hughes Liquid Phase Epitaxy
Gallium Arsenide Solar
Cells as a Function of Intensity,
Temperature, and Irradiation**

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Pasadena, California

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ABSTRACT

Electrical characteristics of Hughes liquid phase epitaxy, P/N gallium aluminum arsenide solar cells are presented in graphical and tabular format as a function of solar illumination intensity and temperature. Each set of graphs and tables is repeated after the solar cells were exposed to 1-MeV electron fluences of, respectively, 0, 10^{14} , 10^{15} , and 10^{16} e/cm².

ACKNOWLEDGEMENT

The authors gratefully acknowledge the invaluable assistance of James Hix and Diane Engler for computer programming and meticulous attention to detail in producing the tables and plots. The absorptance measurements were performed by Jerry Brown of the TRW Thermophysics Laboratory.

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SECTION I

INTRODUCTION

A series of reports is being generated to present parametric characterization data on both state-of-the-art and developmental solar cells of interest to the photovoltaic community. These data consist of electrical characteristics of the candidate solar cell under a wide range of temperature and illumination intensity combinations of the type encountered in typical space applications. This series (JPL Publication 78-15) consists of a number of reports, each report being devoted to a particular type of solar cell and identified by a volume number. Previously published reports with their associated solar cell descriptions are listed in the bibliography. Each report consists primarily of working graphs and tables and does not address itself to interpretive conclusions. The formatting of this series of reports is relatively invariant to facilitate comparisons between the characteristics of any of the cell types considered in the series. This report contains a set of parametric data on Hughes liquid phase epitaxy (LPE) gallium arsenide solar cells.

SECTION II

CELL DESCRIPTION

The cells reported here were manufactured by Hughes Research Lab. The cells are made by growing a GaAs buffer layer by LPE on a conventional n+ GaAs substrate. The first portion of the buffer layer is n-type (doped with 10^{17} cm⁻³ Sn), and the second portion is p-type (doped with 10^{18} cm⁻³ Be), resulting in a P/N junction. A window of p-type Al_xGa_{1-x}As (with x typically 0.95) is grown over the buffer layer using Be doping to a concentration of 10^{18} cm⁻³. Total buffer layer thickness is 10 microns, junction depth is < 0.5 microns and window layer thickness is < 0.5 microns. Total cell thickness is approximately 300 microns. The front contact geometry is a pattern of 24 parallel grid fingers, each terminating in a 0.079 by 2 cm busbar located at a cell edge. Front contact material is sputtered Au-Zn followed by an Ag evaporation. The rear contact is a picture frame pattern of evaporated Au-Ge-Ni followed by an Ag evaporation. The cells used in this test were covered with 7940 fused silica coverslides, 300 microns thick with an anti-reflection coating of MgF₂ and a 350 micron cut on filter. The coverslides were mounted to the cells using Dow Corning DC 93-500 adhesive.

SECTION III

TEST PROGRAM

The solar cells were mounted on a copper test plate using General Electric RTV 560 silicone adhesive. The test plate was in turn mounted to a heat sink with provisions for both heating and cooling so that the cells could be maintained at the desired temperature independent of the solar intensity. All testing was performed in vacuum at a pressure of less than 1×10^{-6} torr.

The illumination source used was a Spectrolab Model X-25 Mark II Spectrosun filtered solar simulator. This simulator uses an optical integrator lens in the optical system that uniformly distributes a relatively collimated light beam at specific distances from a 2.5-kW short-arc xenon lamp. A system of filters modifies this spectral distribution so that it approximates that of space sunlight. The light beam provides a pattern having a uniformity of $\pm 1\%$ over an area of 225 cm^2 at the test plane. Illumination intensity is varied by position of the simulator in combination with transmission filters. The solar simulator beam is introduced into the vacuum chamber through a window of 7940 fused silica. The solar intensity and spectral integrity of the solar simulator are constantly monitored and maintained using space-calibrated standard cells obtained with the NASA/JPL solar cell balloon flight standardization program. Photographs of the solar cell, the assembled plate, and the experimental characterization test facility are shown in Figures A-1 through A-4 in the Appendix.

The temperature range covered in these measurements was -20 to 200°C , while the solar intensity range covered was 50 to 500 mW/cm^2 . The data were taken at each environment point in the matrix in the form of an I-V curve. The appropriate parameters were then read from the I-V curves and punched on cards for the computer analysis and curve plotting functions. The cell temperature was monitored by a thermocouple attached to the busbar of a cell under test. Prior, intermediate, and post-test ambient measurements were performed daily to ensure that the accuracy and stability of the test equipment and the test specimens themselves were maintained within $\pm 2\%$ during the course of the testing program.

After the initial solar cell measurements over the above temperature and intensity ranges, the test plate was mounted in the evacuated target chamber of the JPL Dynamitron electron accelerator and irradiated with electron fluences from 5×10^{12} to $1 \times 10^{16} \text{ e/cm}^2$. The incident electron beam energy was adjusted to 1.1 MeV to compensate for the 0.1 MeV loss in penetrating the cover slide. During the irradiation, the cells were maintained at 28°C . I-V curves of the solar cells are measured in situ before and after each irradiation using an Aerospace Controls Model 302 filtered xenon air mass zero (AMO) solar simulator.

After each radiation fluence $\geq 1 \times 10^{14} \text{ e/cm}^2$, the solar cells were annealed for approximately 16 hours at 60°C , then remeasured. The annealed cell data is used in the plots of Figures 73 through 77, but the annealing changed the current and power readings by at most 1.5% . In addition, the irradiations were interrupted after reaching fluences of 10^{14} , 10^{15} , and 10^{16} e/cm^2 at which time the test plate was taken back to the Environmental

Test Chamber and subjected to the complete range of temperatures and intensities described above. Complete sets of plots and tables for the cell electrical behavior after each radiation fluence are included in the chart pack for this volume.

Three cells from the same lot of cells, two with cover slides and one without, were sent to TRW for absorptance measurements. These measurements were made using a Gier Dunkle integrating sphere spectrometer. The reflectance is measured over the wavelength range 0.28 to 2.5 microns. Absorptance is calculated by weighting the reflectance with the AMO spectrum and subtracting from one.

SECTION IV

DISCUSSION OF RESULTS

A computer program computes statistical averages and standard deviations with respect to the measured cells for each intensity-temperature measurement condition. It then produces summary tables, as shown in Tables 1 to 7, that display averages and standard deviations of the cell characteristics in a two-dimensional array format, one dimension representing cell temperature and the second dimension representing incoming light intensity (AMO spectrum). The program then produces plots of the various electrical parameters of interest, with either incident intensity or cell temperature as the independent variable, as shown in Figures 1 to 14. Least square fits to the data points are then made automatically to the measured data points using a second-degree polynomial for most parameters. The curve factors, AMO efficiencies, V_{oc} and V_{mp} data points, are not fit but interconnected from point to point. In addition, the program calculates the temperature coefficients of the pertinent cell electrical parameters of interest, using the aforementioned curve fits, and plots these as a function of temperature, with intensity as a parameter, as shown in Figures 15 through 18. Similarly, Figures 19 through 36 and Tables 8 through 14 were produced for the 1×10^{14} e/cm² data, Figures 37 through 54 and Tables 15 through 21 for the 1×10^{15} e/cm² data, and Figures 55 through 72 and Tables 22 through 28 for the 1×10^{16} e/cm² data.

The figures are intended to be working artifacts; that is, they are formatted in such a way that they can supply information of a general nature or may be used to generate predictions, comparisons, computer input data, etc. To facilitate comparisons and inputting, all units are standardized as follows:

- (1) All currents are in units of mA/cm².
- (2) All voltages are in units of mV.
- (3) All power outputs are in units of mW/cm².
- (4) All curve factors are in dimensionless units.
- (5) All efficiencies are in percentages and are based on cell area.

- (6) All temperatures are in $^{\circ}\text{C}$.
- (7) All incoming intensities are in units of mW/cm^2 and are representative of an AMO spectrum.
- (8) All geometric dimensions are in units of cm or microns (whichever is most convenient conceptually).

The tables included in this report contain complete numerical information with respect to the average values of the following solar cell electrical parameters: I_{sc} , V_{oc} , I_{mp} , V_{mp} , P_{max} , CF, and efficiency at each intensity-temperature combination. For each such parameter at each such intensity-temperature combination, the standard deviation is presented to provide estimates of statistical validity. All efficiency, current, and power output data are on the basis of unit area derived by dividing measured output by total cell area.

The average absorptance of the two covered cells was found to be 0.779 and the average absorptance of the bare cell was 0.768.

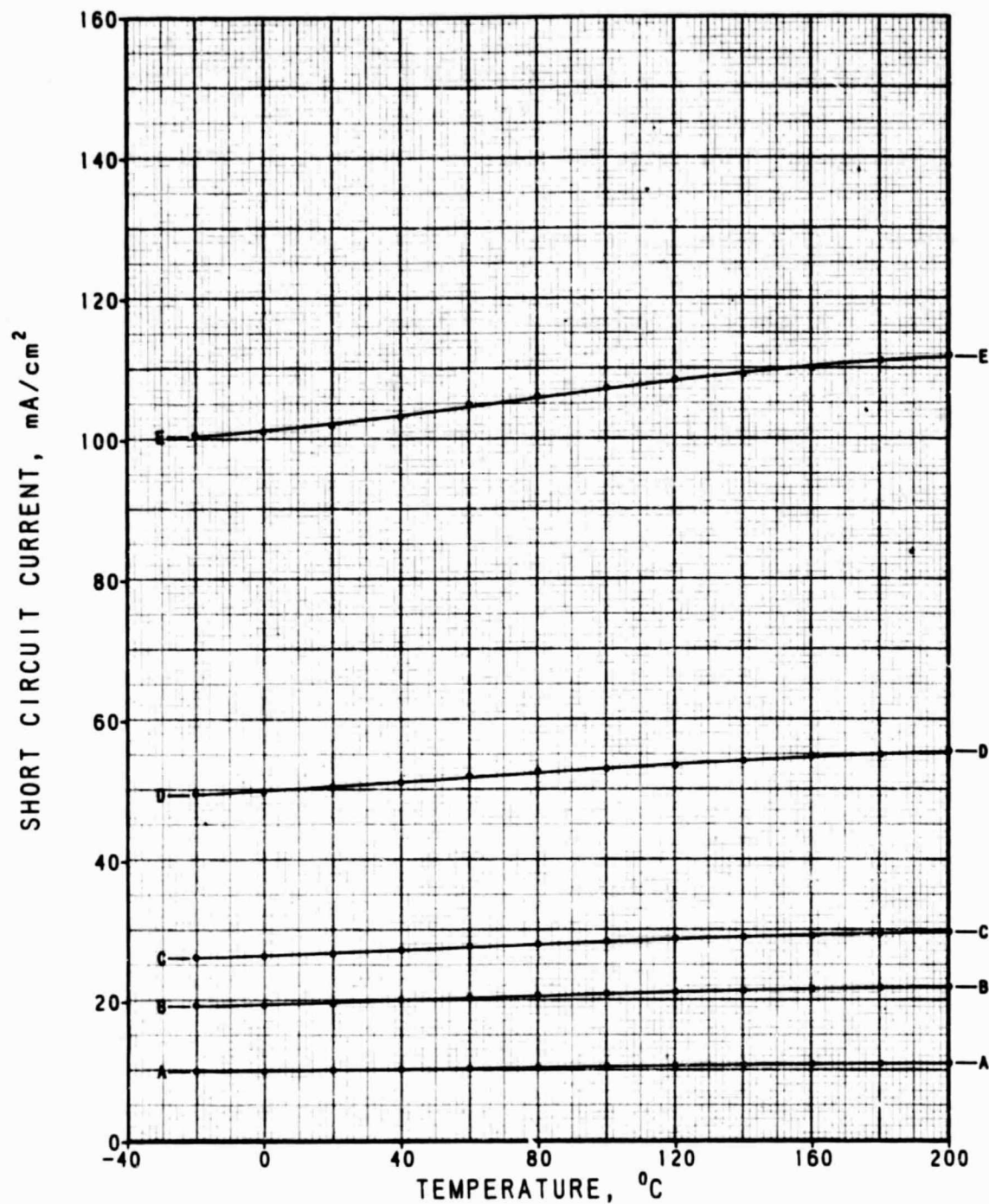
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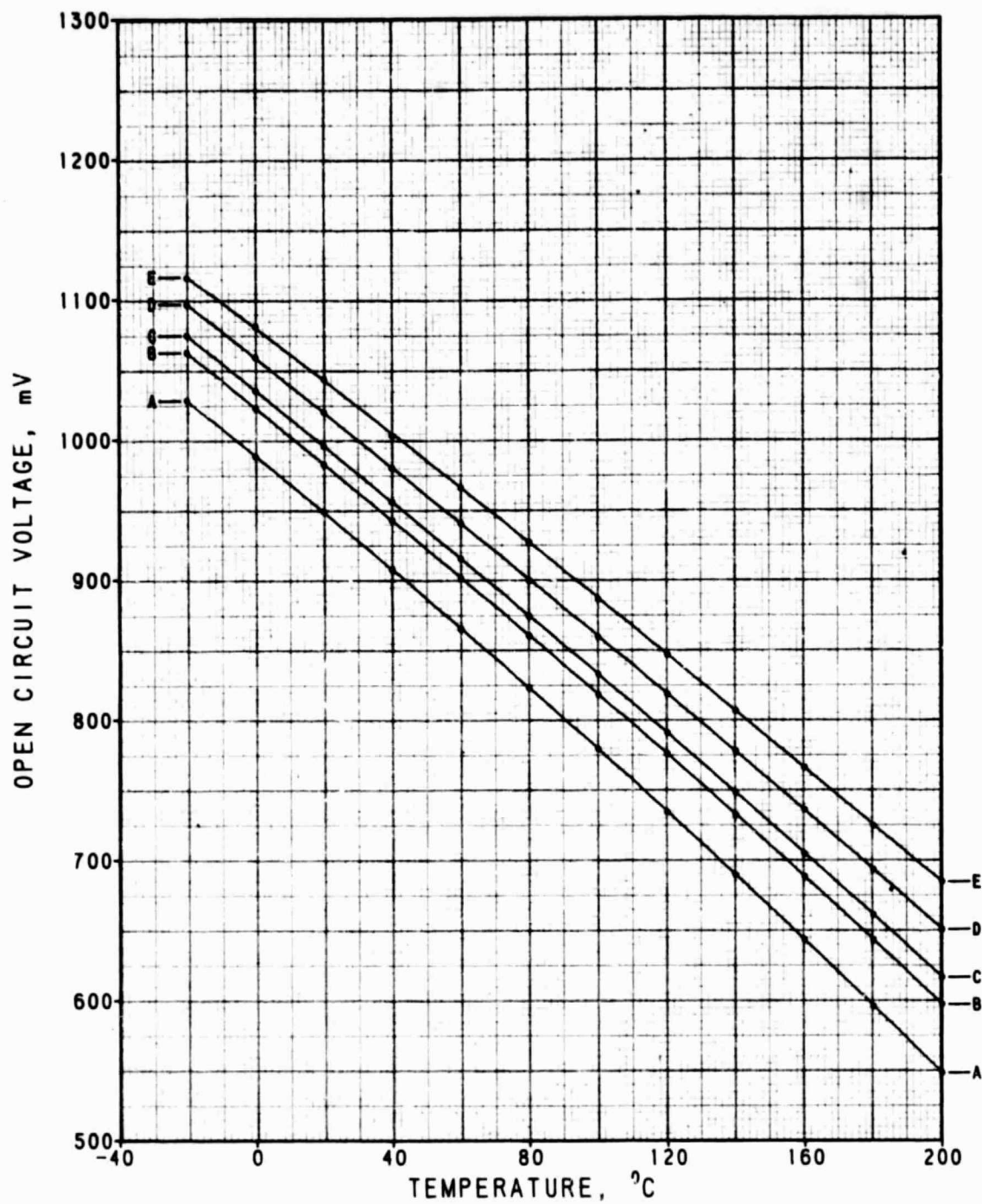


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 1. Average I_{sc}/cm^2 as a Function of Temperature
Pre-Irradiation

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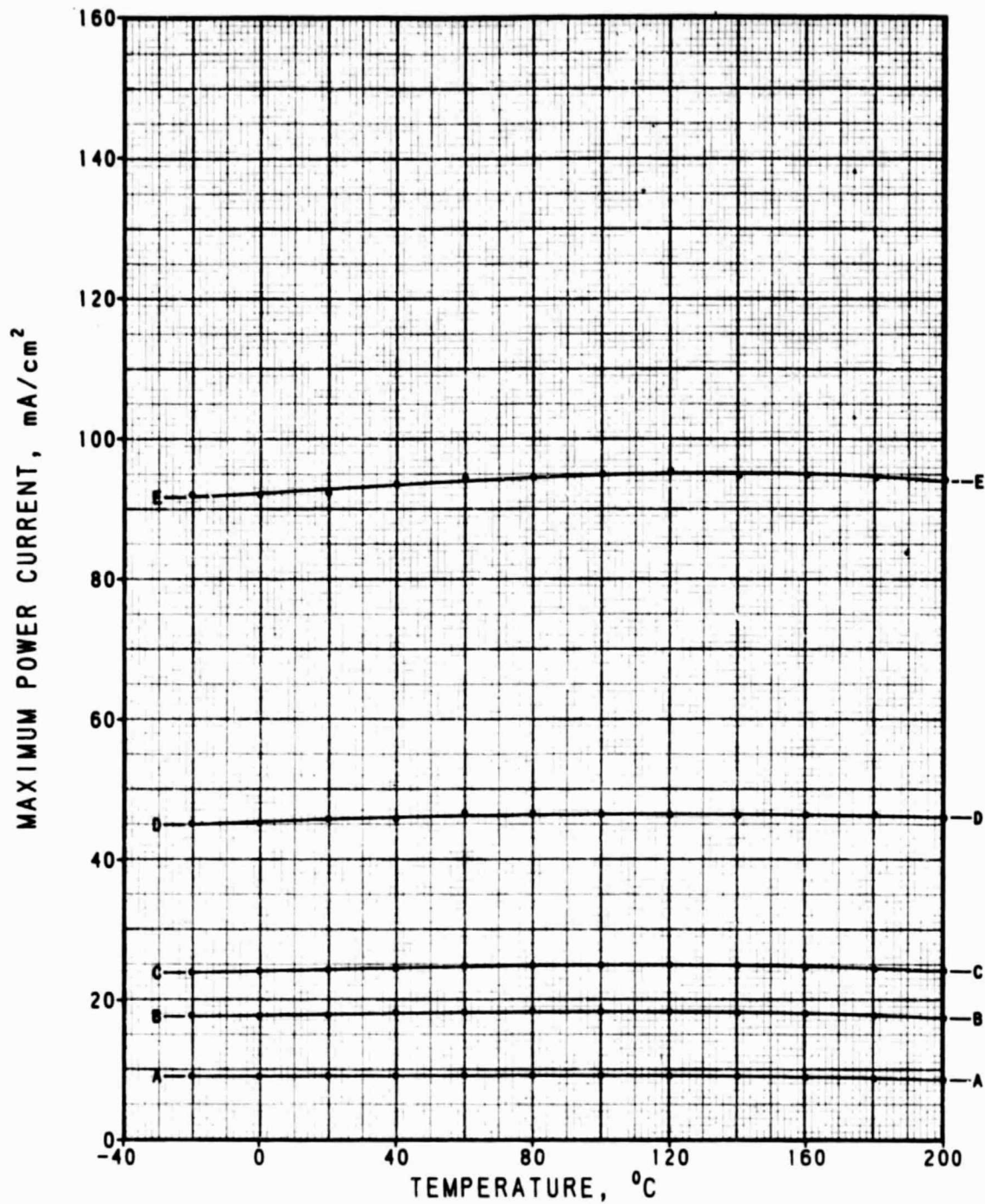


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 2. Average V_{oc} as a Function of Temperature
Pre-Irradiation

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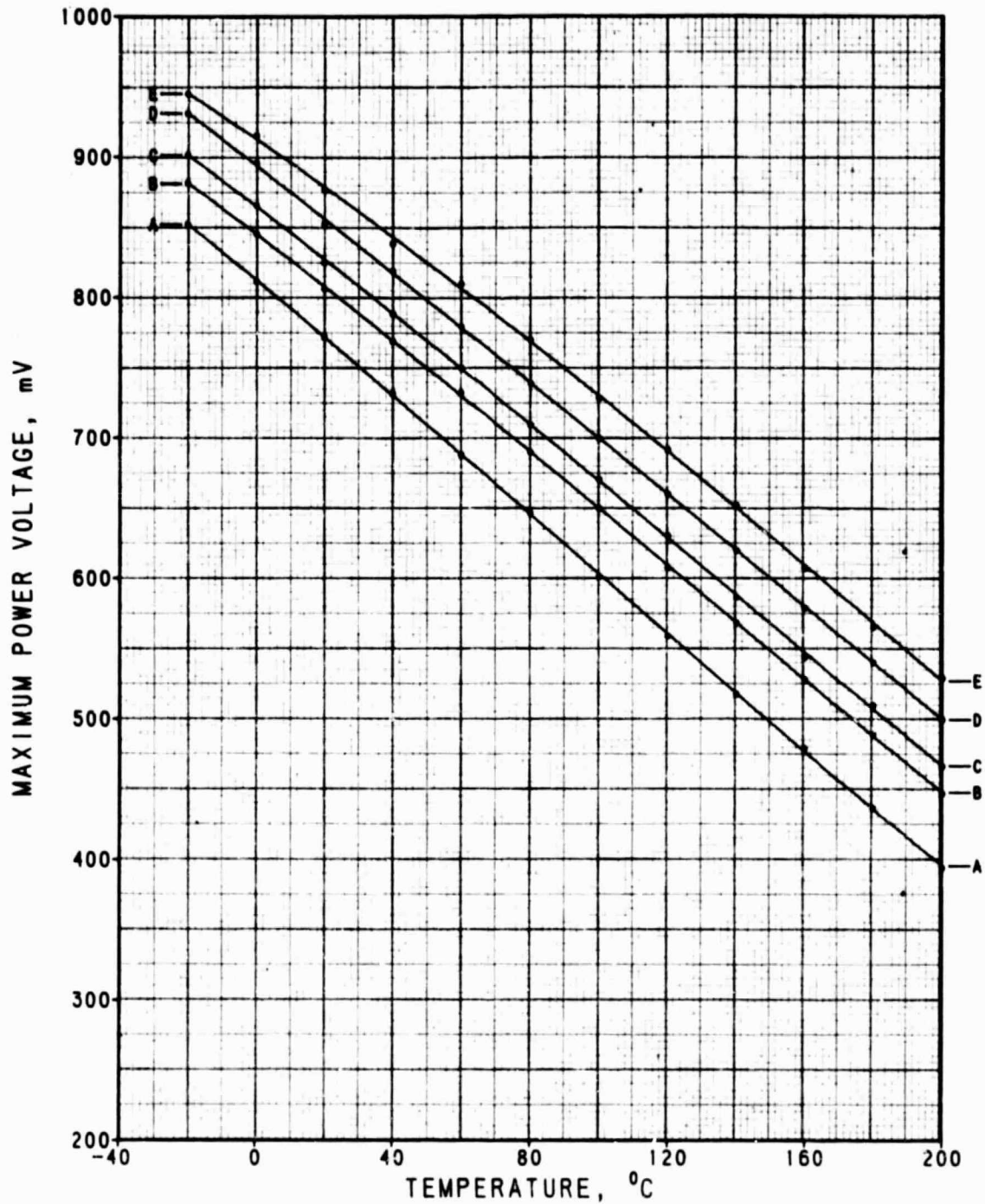


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 3. Average I_{mp}/cm^2 as a Function of Temperature
Pre-Irradiation

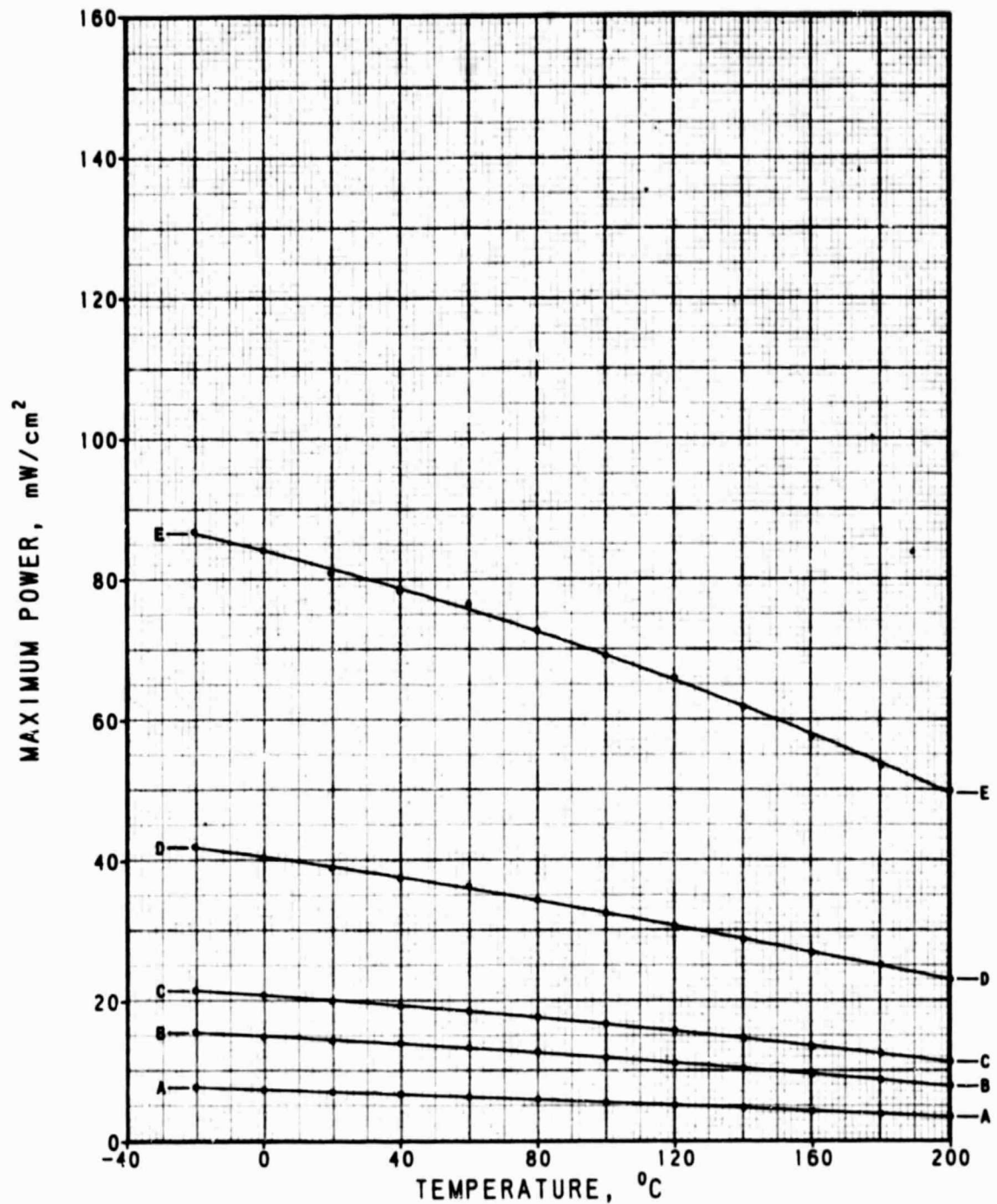
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ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
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CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-54

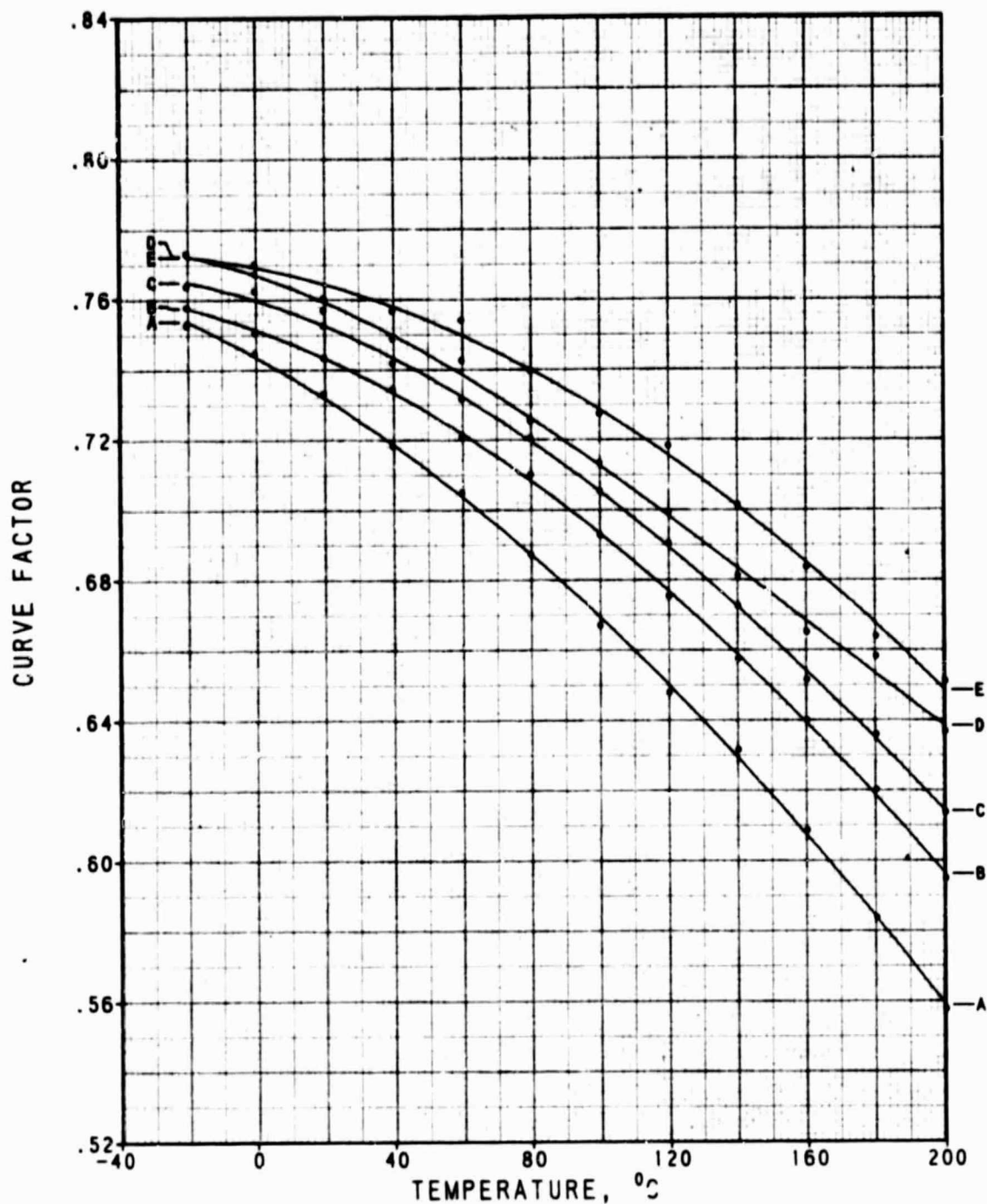
Figure 4. Average V_{mp} as a Function of Temperature
Pre-Irradiation



ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
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Figure 5. Average P_{max}/cm^2 as a Function of Temperature
Pre-Irradiation

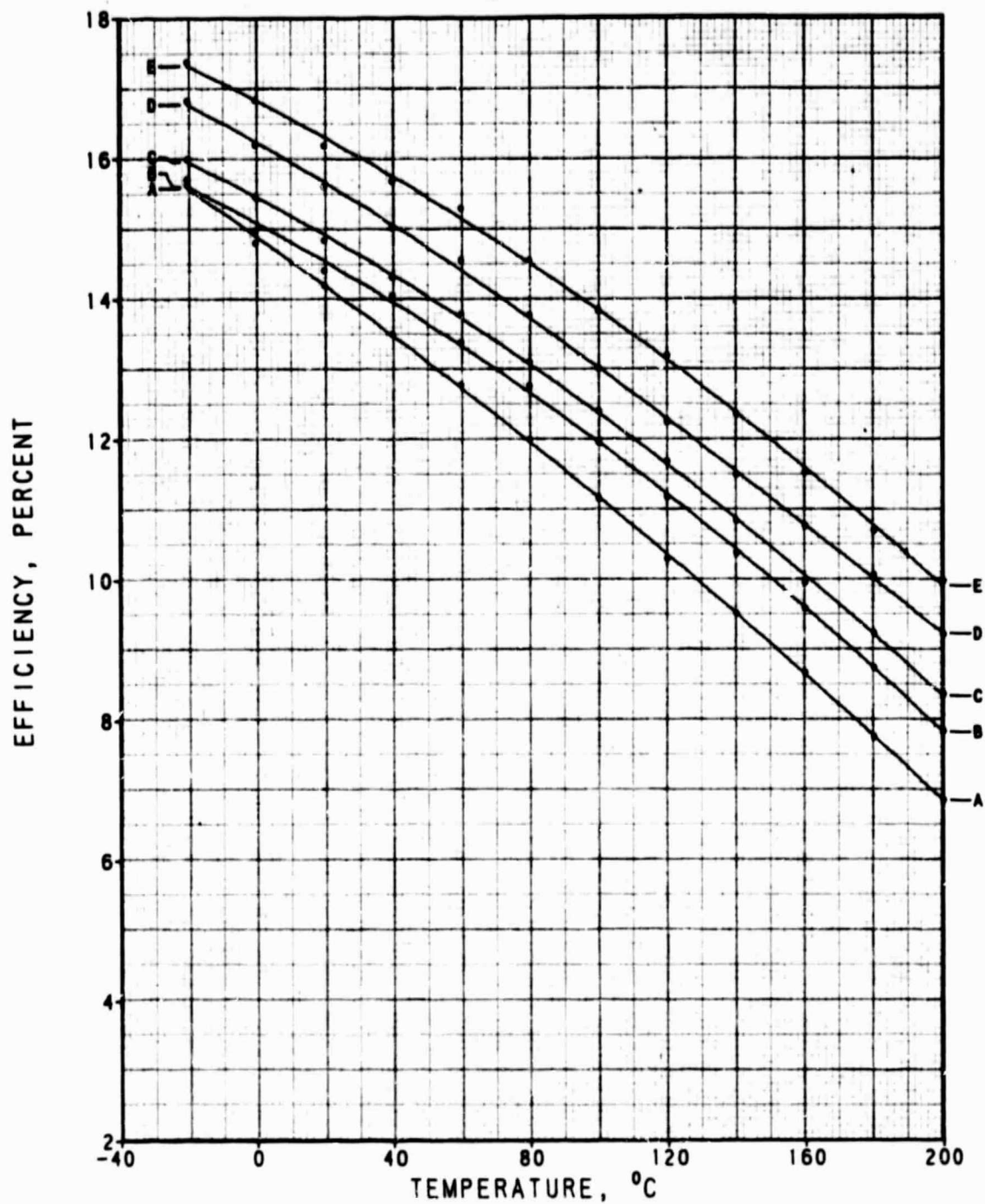


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 6. Average Curve Factor as a Function of Temperature
Pre-Irradiation

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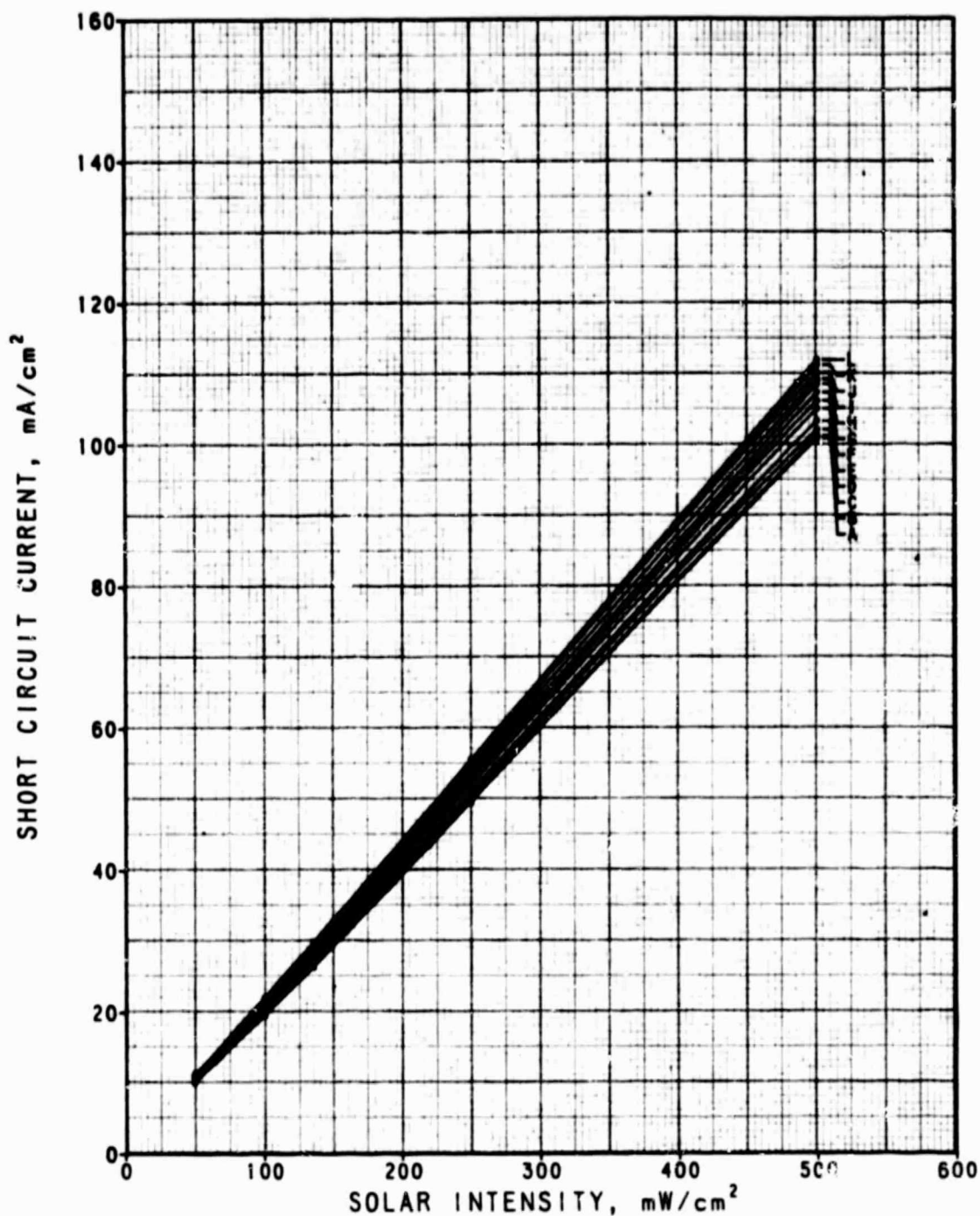


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
T₀₂₀₅ A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 7. Average AMO Efficiency as a Function of Temperature
Pre-Irradiation

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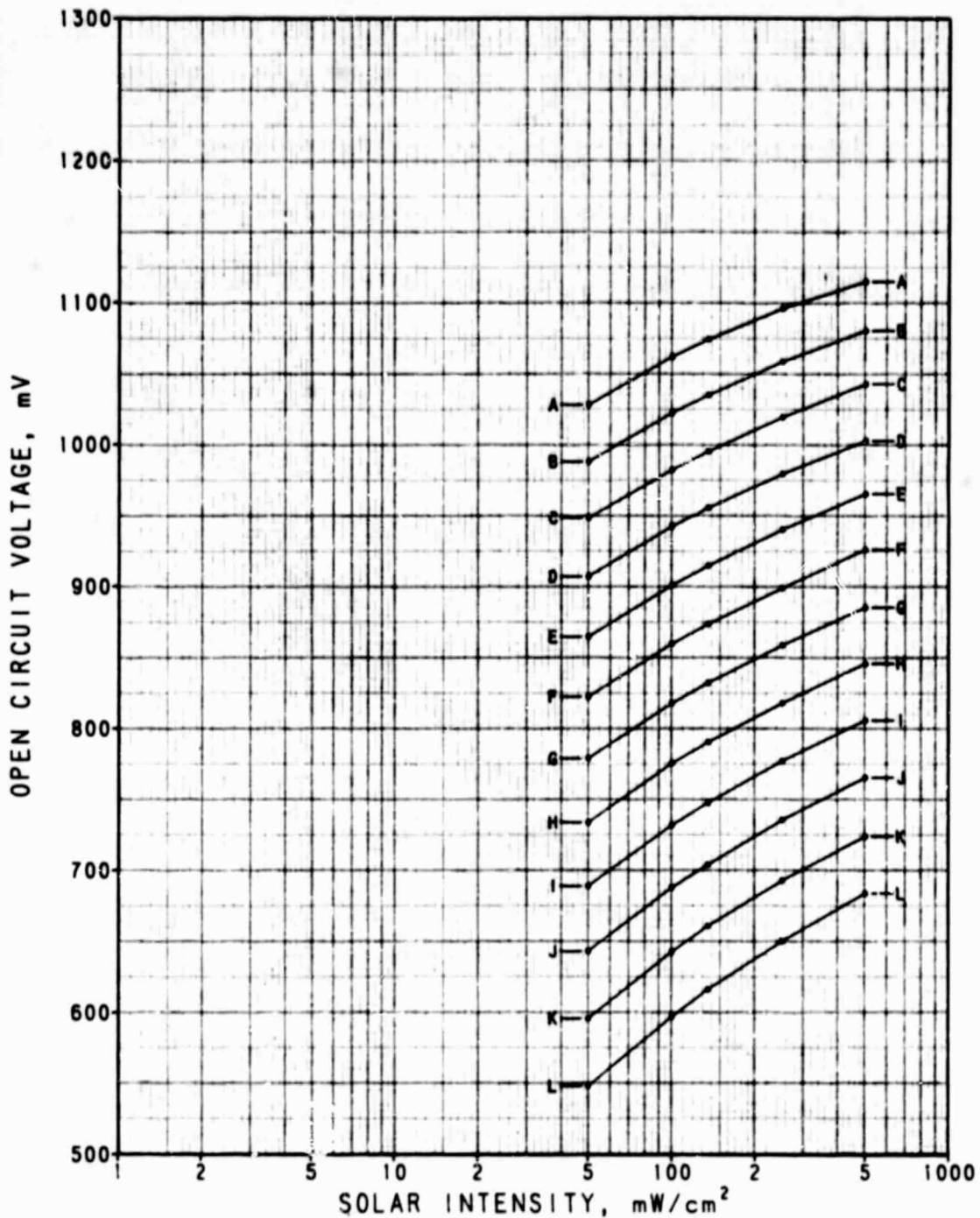


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B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ga Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 8. Average I_{sc}/cm^2 as a Function of Intensity
Pre-Irradiation

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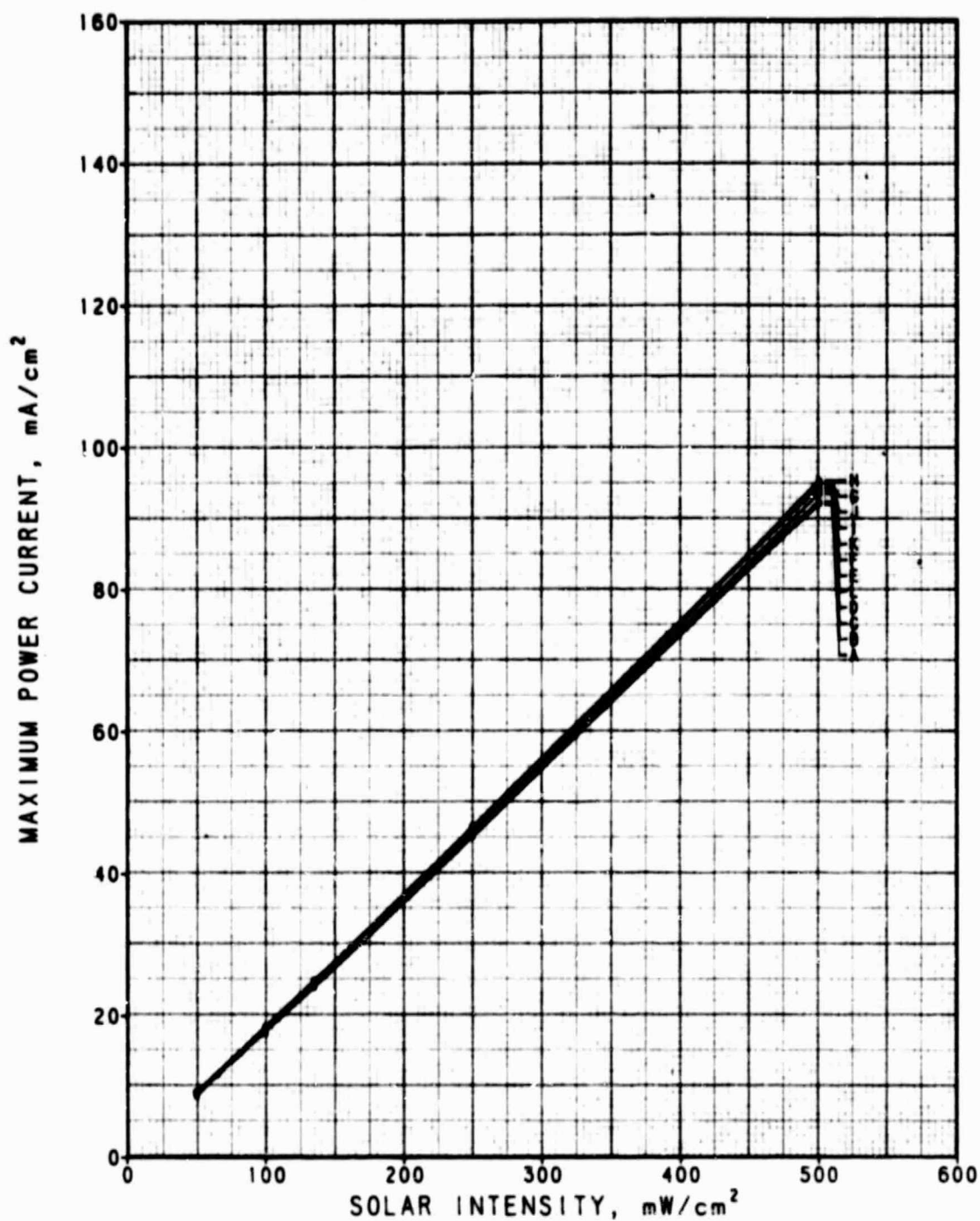


ID	°C	ID	°C
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GeAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 9. Average V_{OC} as a Function of Intensity
Pre-Irradiation

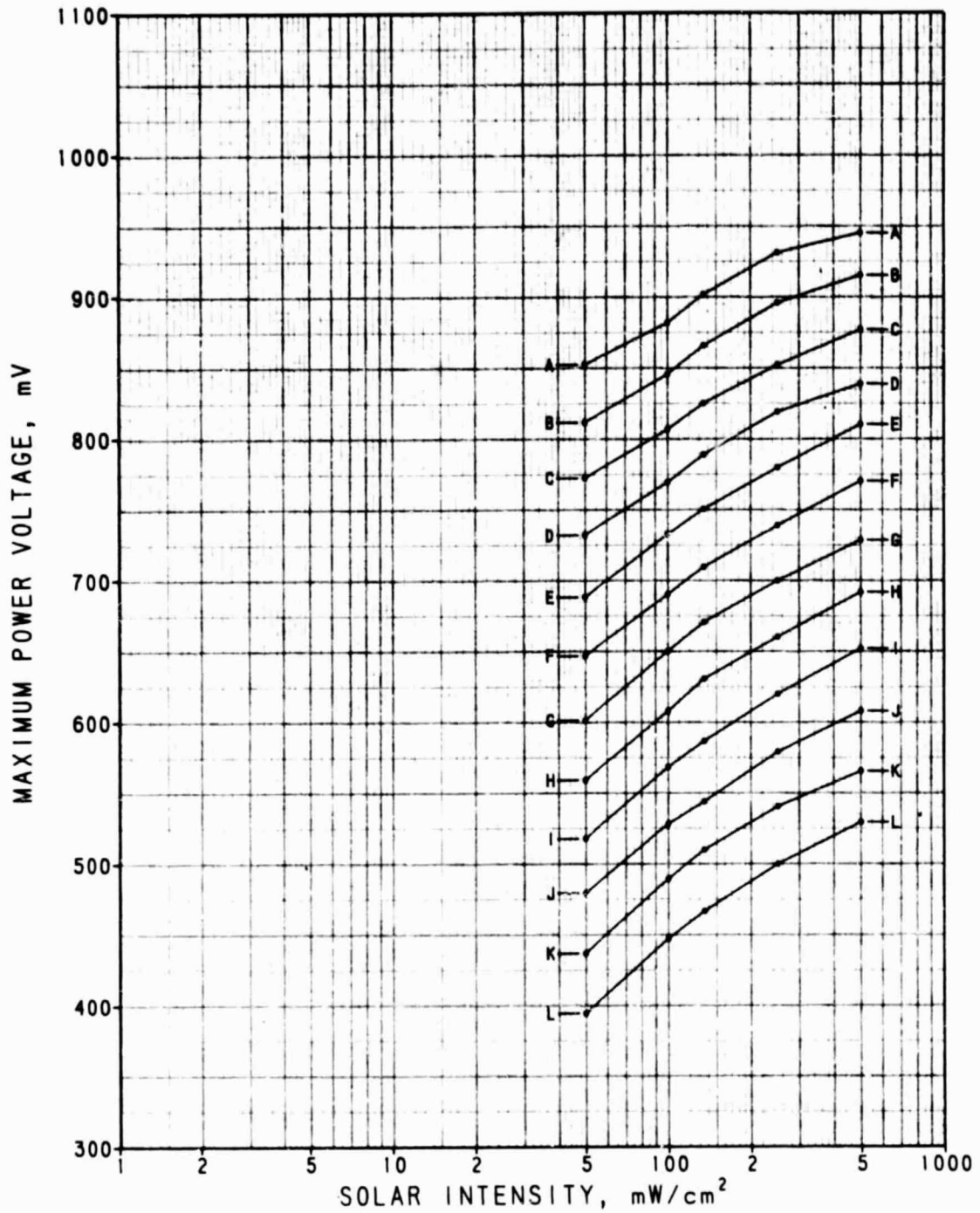
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ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni) Ge Au/Ag
REAR: Au-Zn/Ag
Te265 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 10. Average I_{mp}/cm^2 as a Function of Intensity
Pre-Irradiation

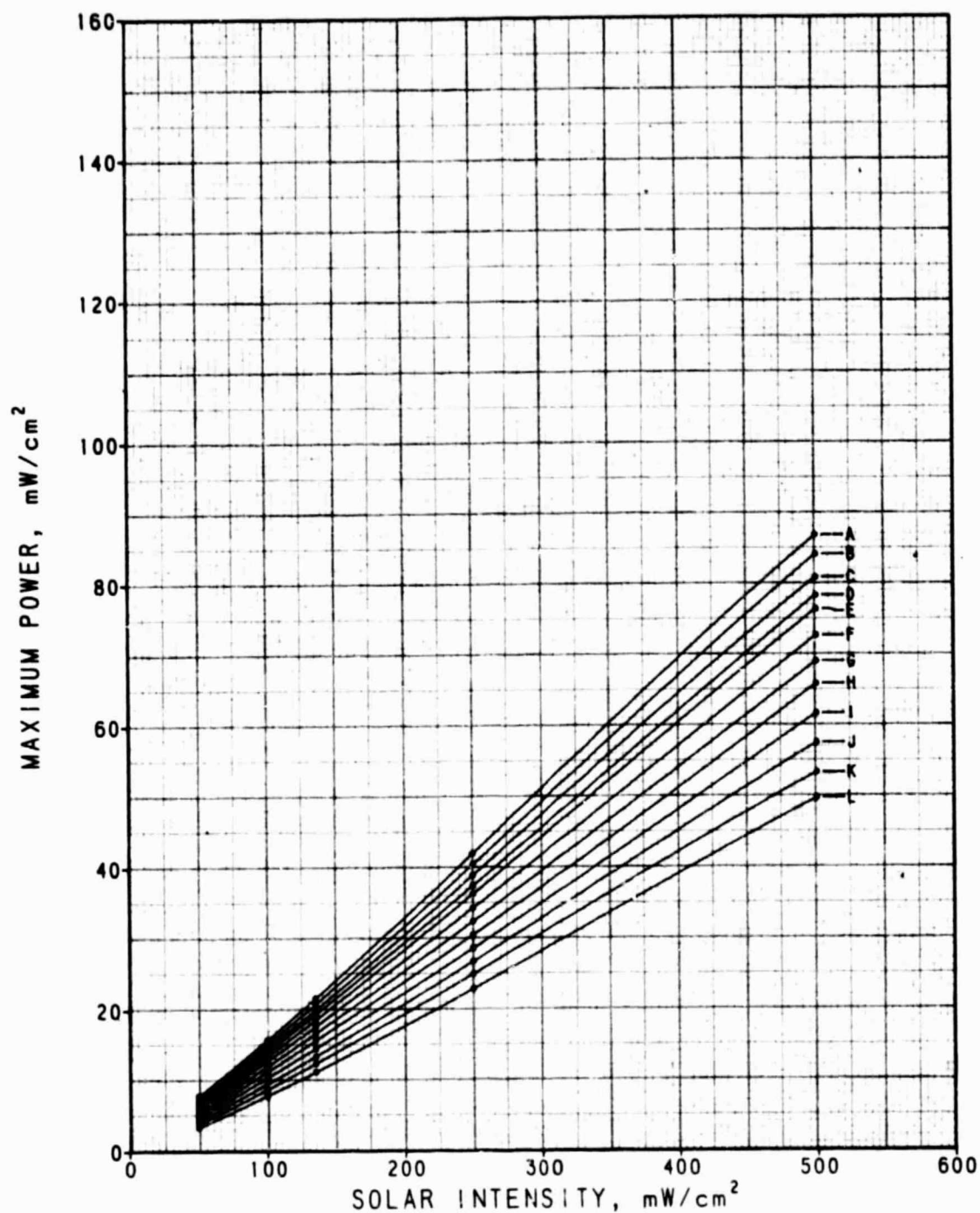


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 11. Average V_{mp} as a Function of Intensity
Pre-Irradiation

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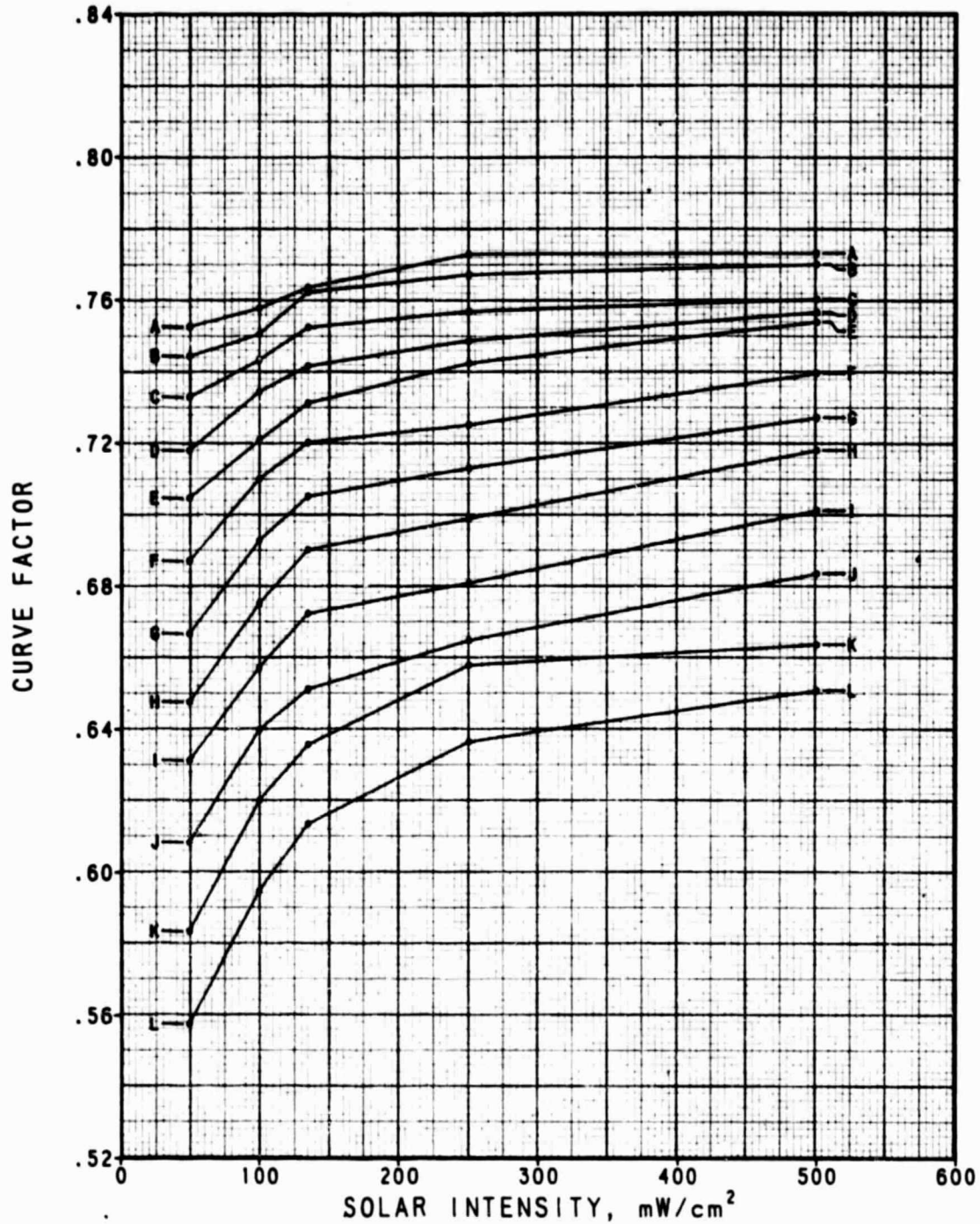


ID	$^{\circ}\text{C}$	ID	$^{\circ}\text{C}$
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 12. Average $P_{\text{max}}/\text{cm}^2$ as a Function of Intensity
Pre-Irradiation

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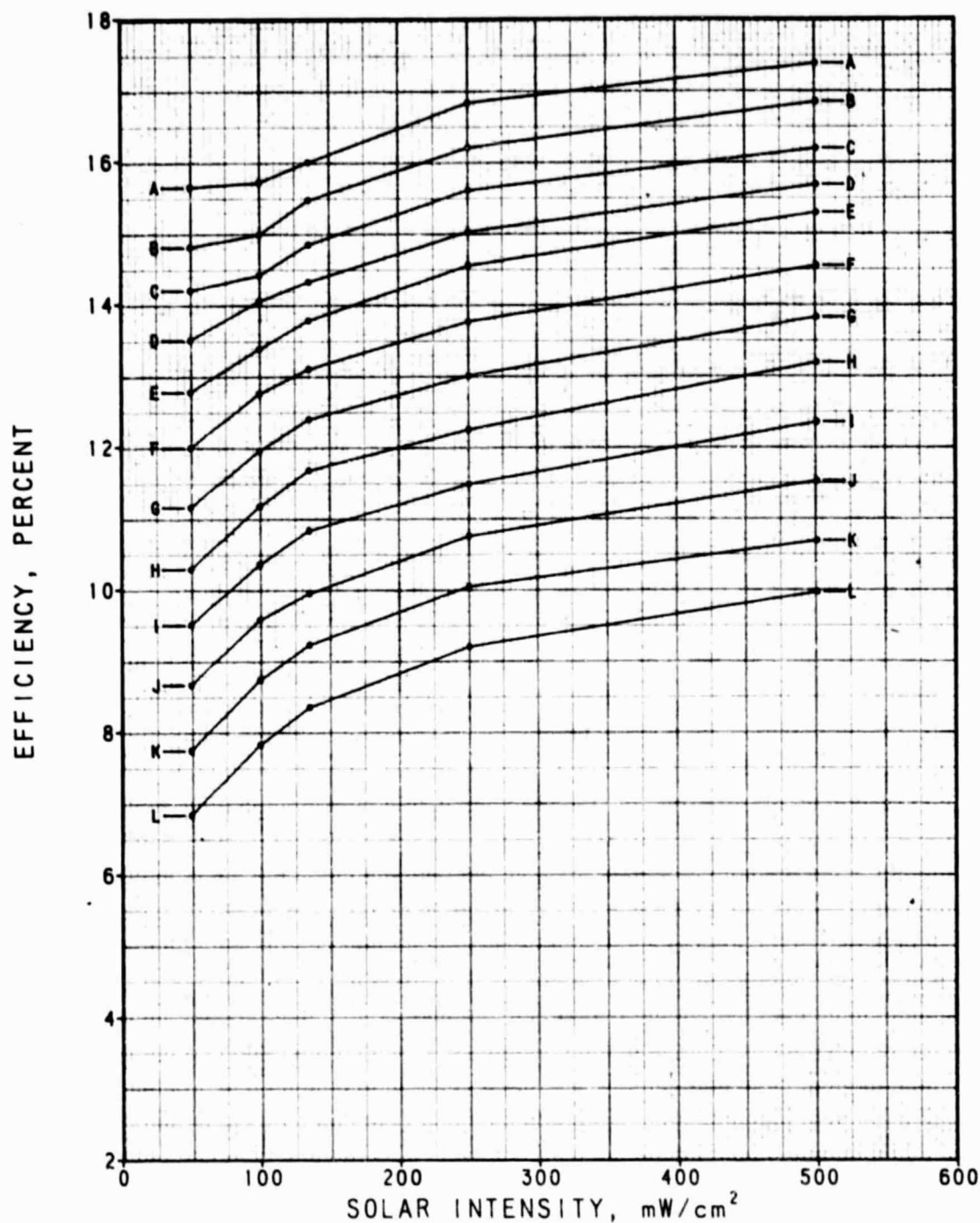


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 13. Average Curve Factor as a Function of Intensity
Pre-Irradiation

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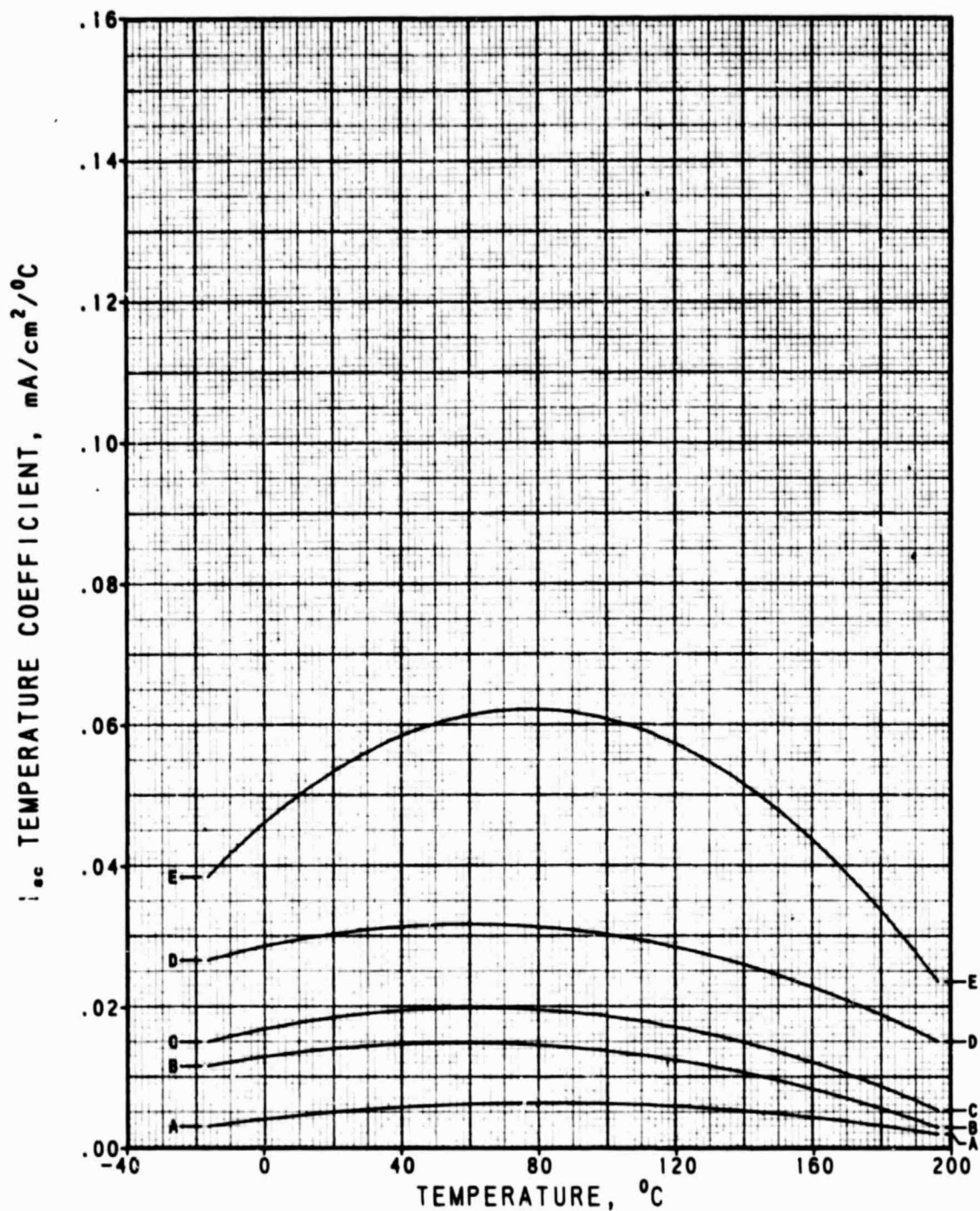


ID	$^{\circ}\text{C}$	ID	$^{\circ}\text{C}$
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 14. Average AMO Efficiency as a Function of Intensity
Pre-Irradiation

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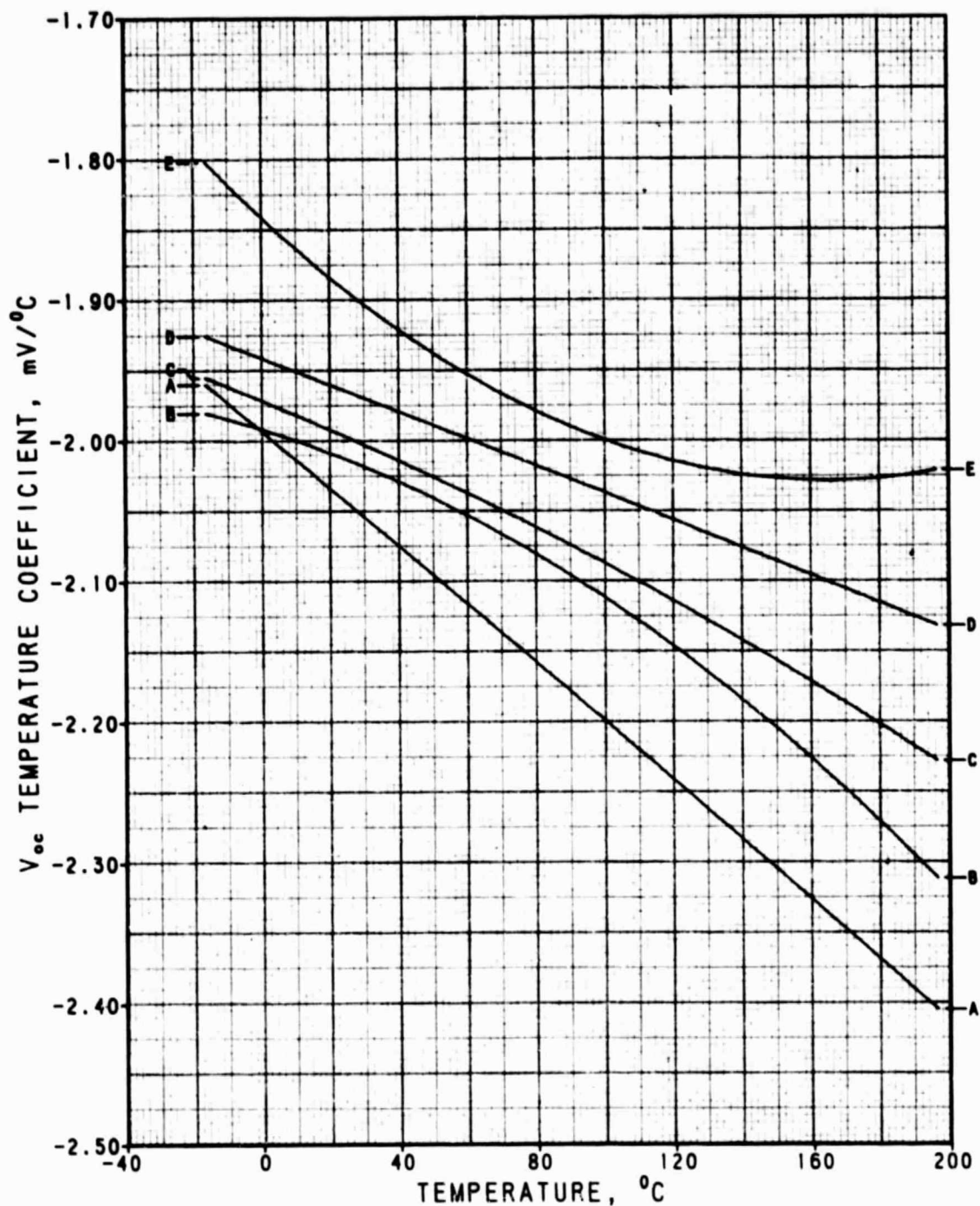


ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 15. I_{sc} Temperature Coefficient
Pre-Irradiation

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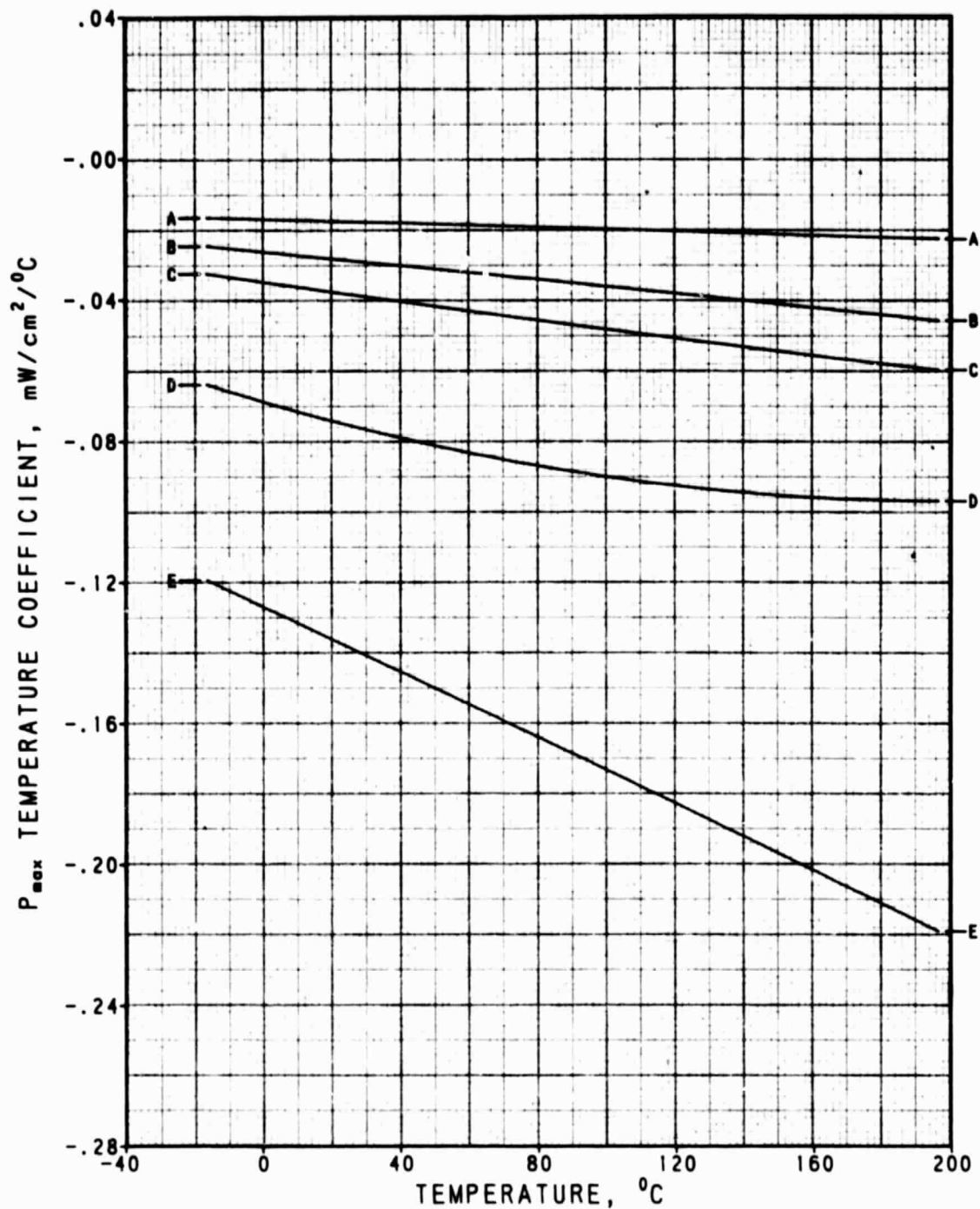


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
T₀205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 16. V_{oc} Temperature Coefficient
Pre-Irradiation

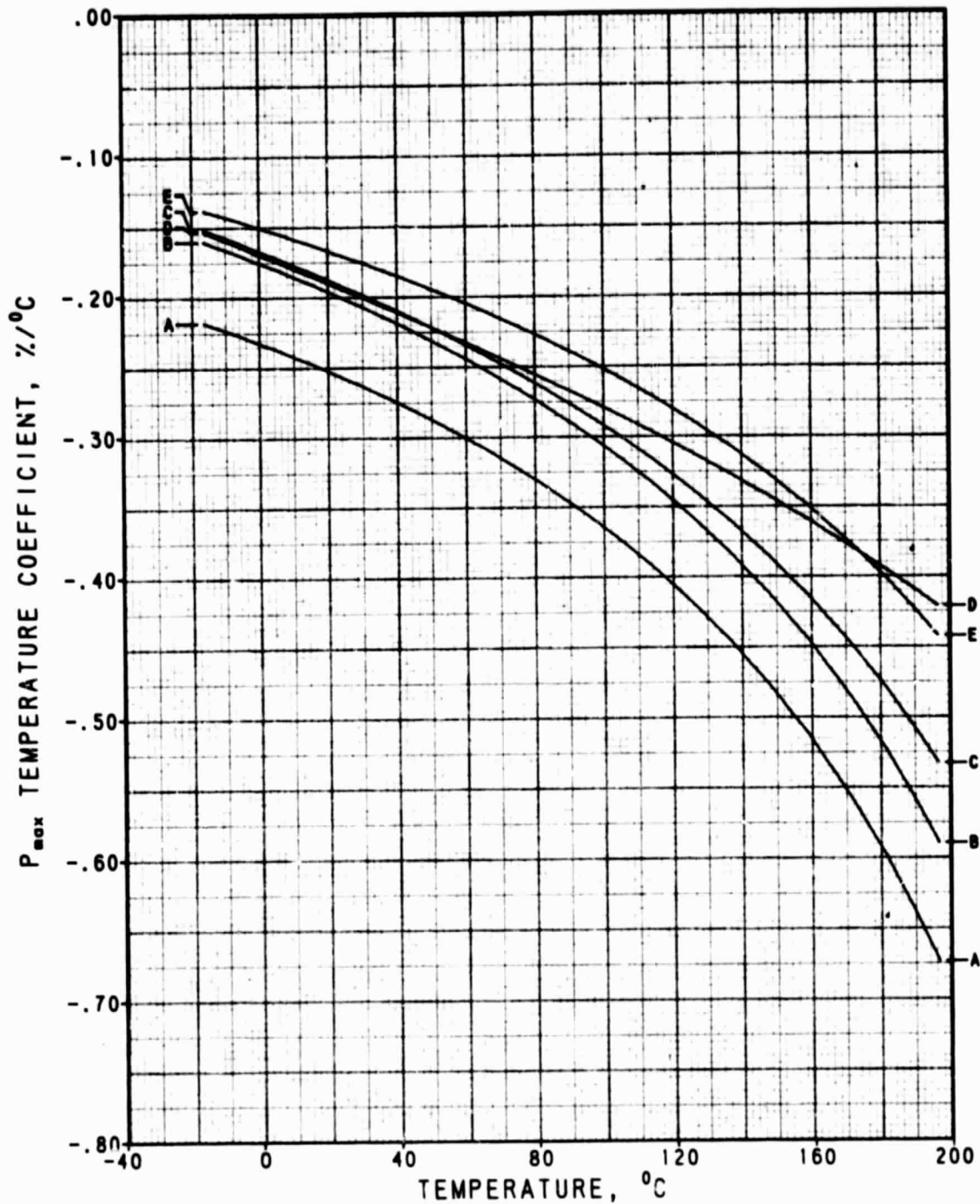
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ID	mW/cm²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
T0205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

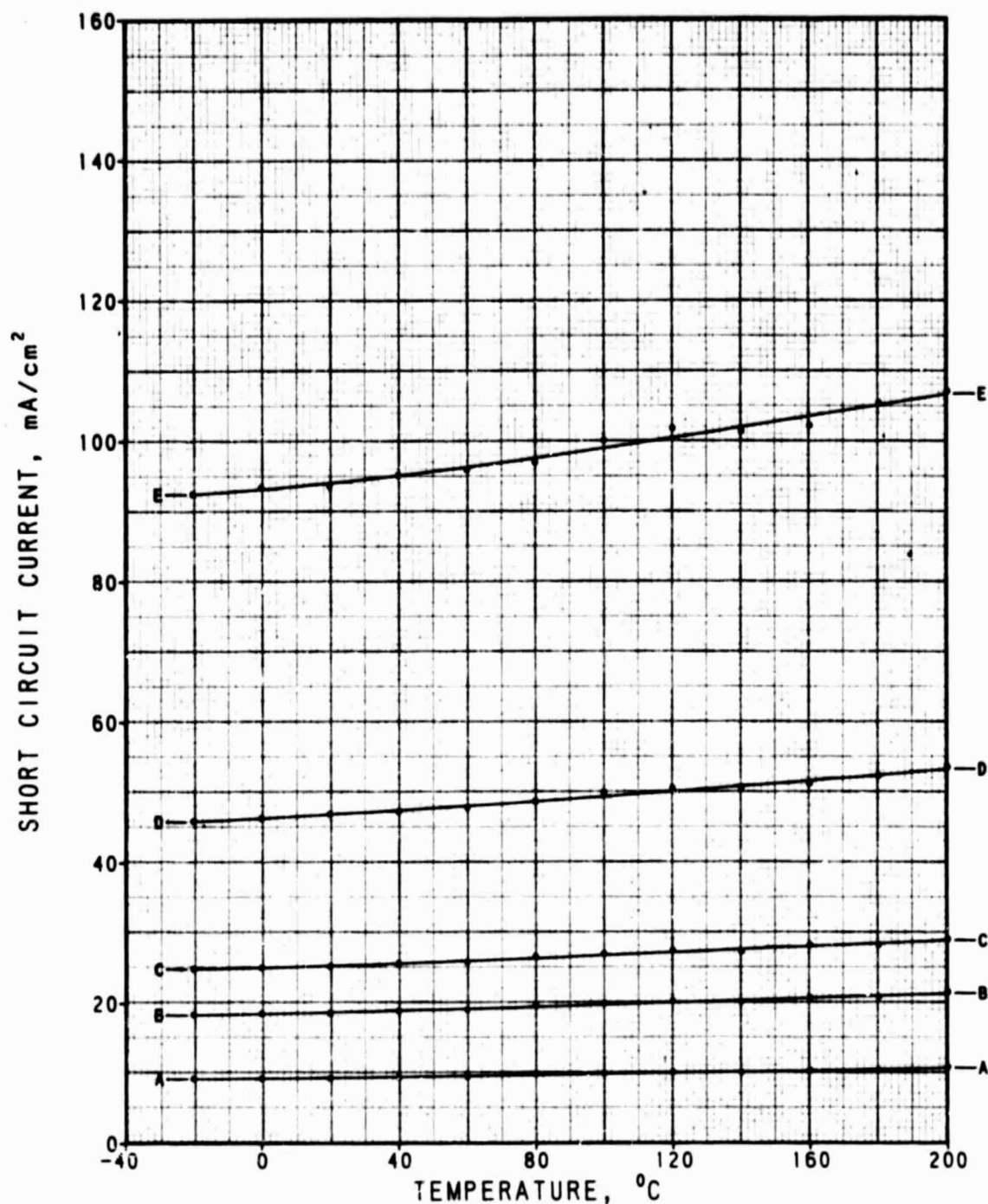
Figure 17. Absolute Pmax Temperature Coefficient
Pre-Irradiation



ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
T₀205 A-R. 7940 COVER .03 CM
PRE-IRRADIATION TM-58

Figure 18. Percent P_{max} Temperature Coefficient
Pre-Irradiation

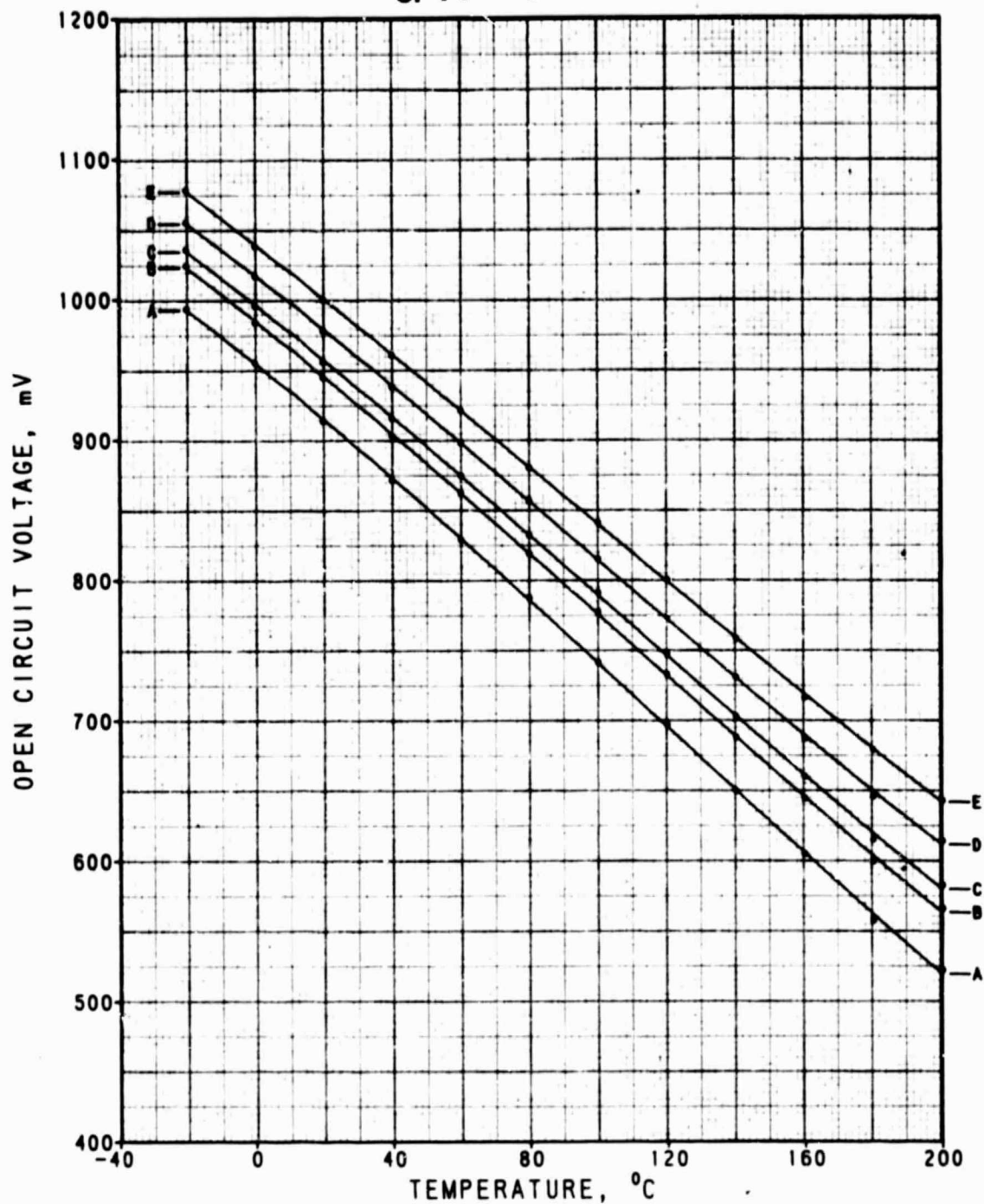


ID mW/cm²
 A 50.0
 B 100.0
 C 135.3
 D 250.0
 E 500.0

HUGHES LPE GaAs CELLS (9/79)
 P/N JUNCTION .LE. 0.5 MICRONS
 WINDOW .LE. 0.5 MICRONS
 2X2X.0305 CM (SAMPLE SIZE 7)
 CONTACTS FRONT: (Ni Ge Au)/Ag
 REAR: Au-Zn/Ag
 Te205 A-R. 7940 COVER .03 CM
 AFTER 1.E14 e/cm²2 TM-58

Figure 19. Average I_{sc}/cm^2 as a Function of Temperature
 After 10^{14} electrons/cm²

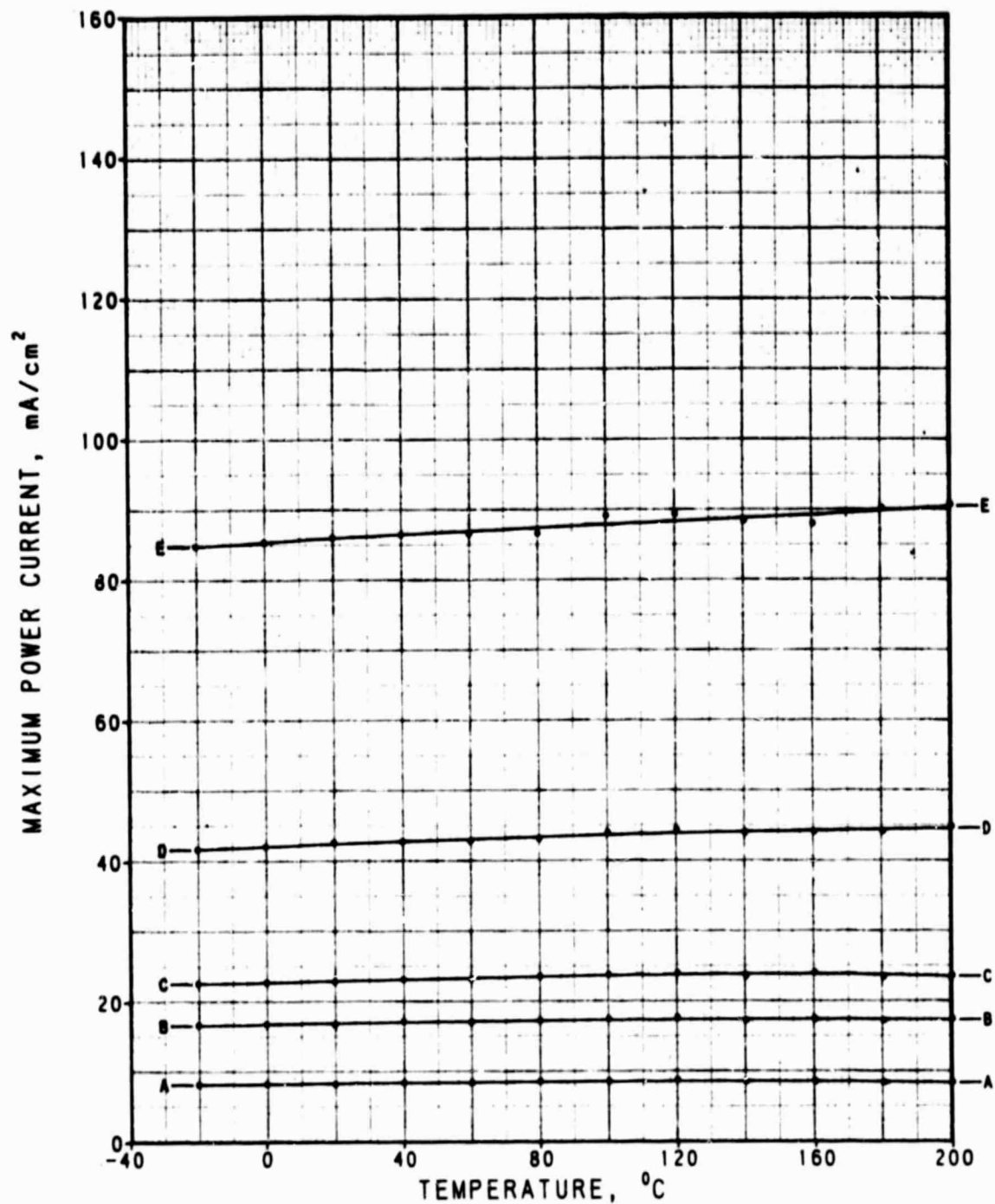
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ID	mW/cm²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7946 COVER .03 CM
AFTER 1.E14 e/cmsec2 TM-58

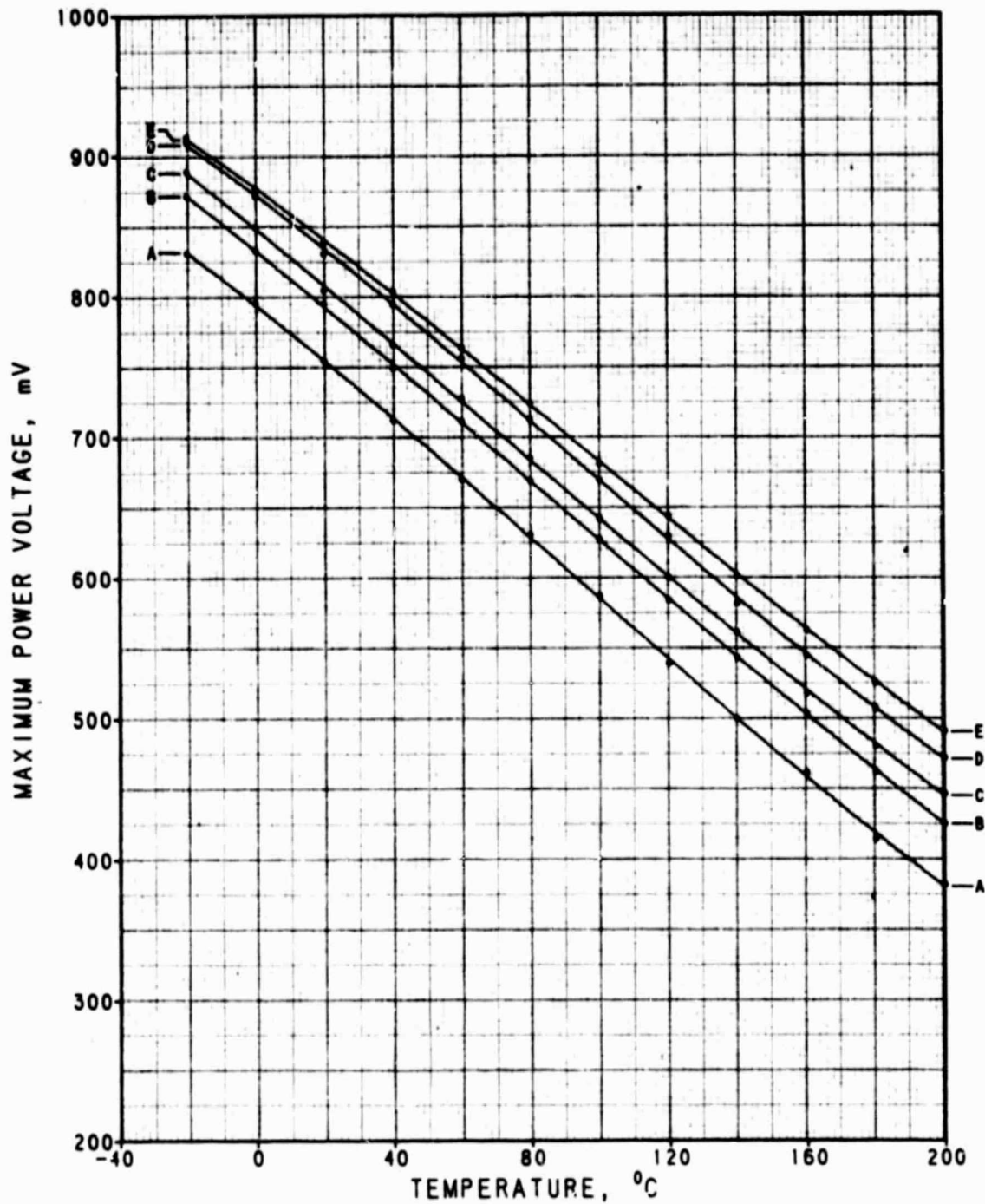
Figure 20. Average V_{OC} as a Function of Temperature
After 10^{14} electrons/cm²



ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 21. Average I_{mp}/cm^2 as a Function of Temperature
After 10^{14} electrons/cm²

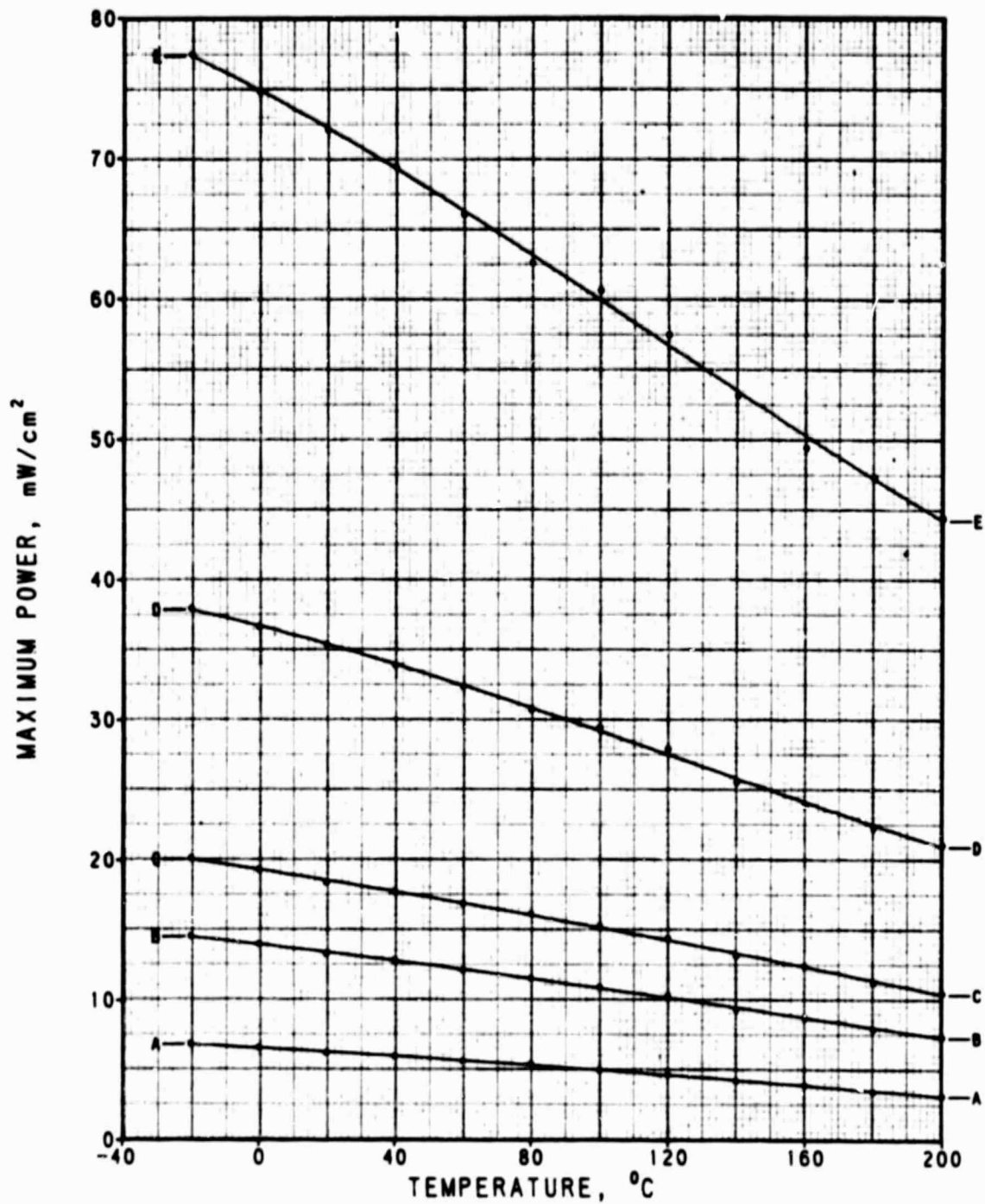


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cmsec2 TM-58

Figure 22. Average V_{mp} as a Function of Temperature
After 10^{14} electrons/cm²

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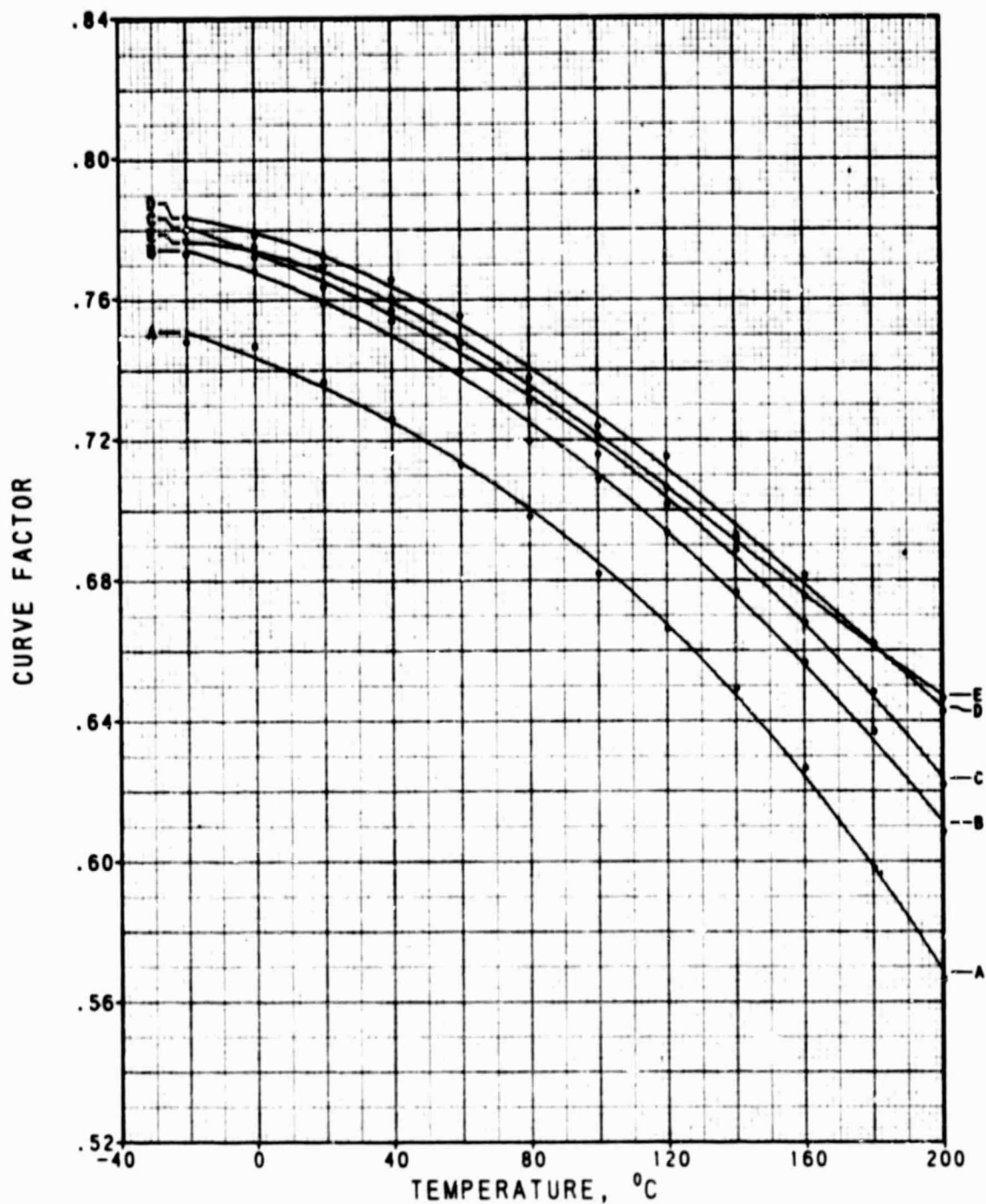


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 23. Average P_{\max}/cm^2 as a Function of Temperature
After 10^{14} electrons/cm²

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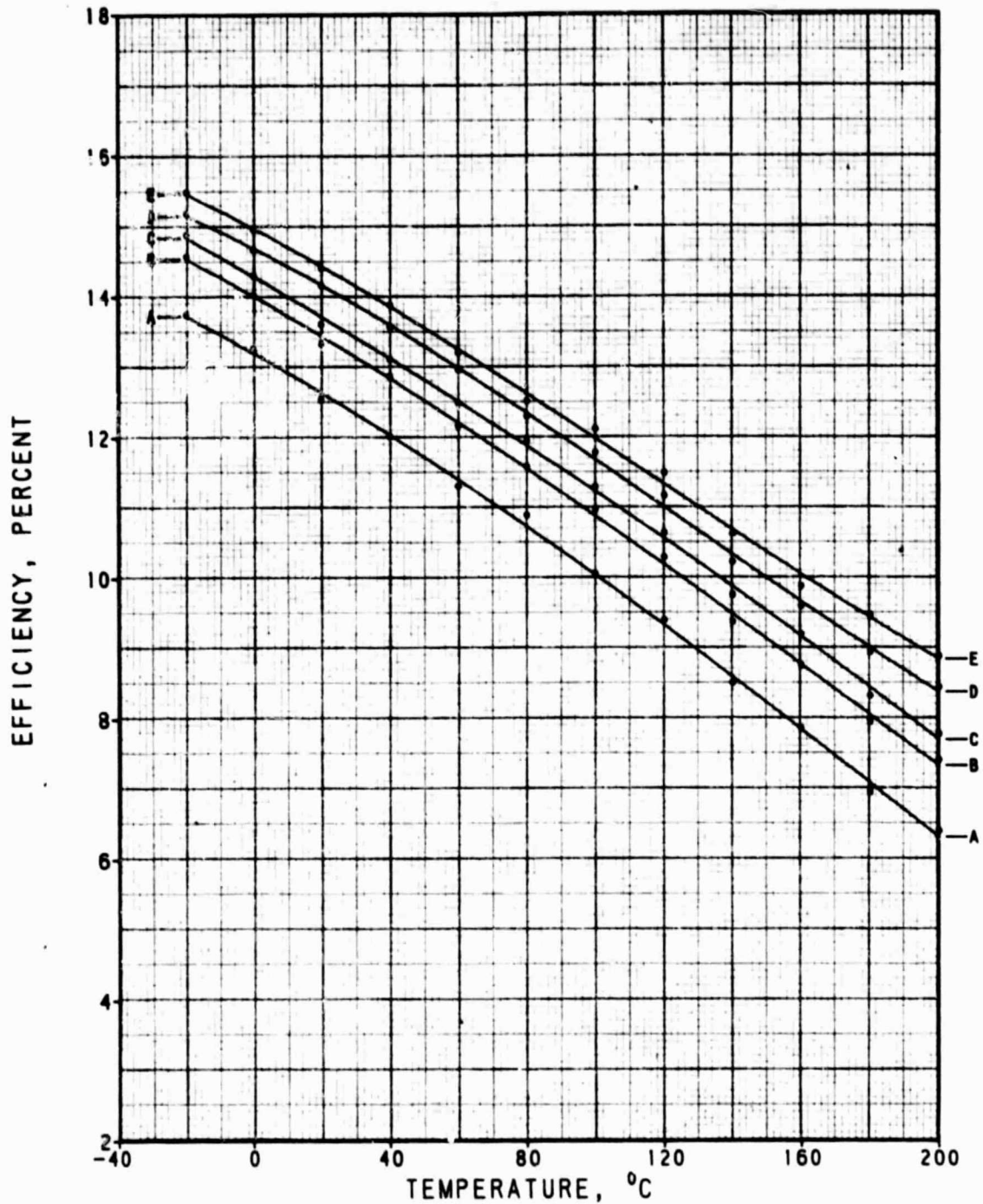


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm²2 TM-58

Figure 24. Average Curve Factor as a Function of Temperature
After 10^{14} electrons/cm²

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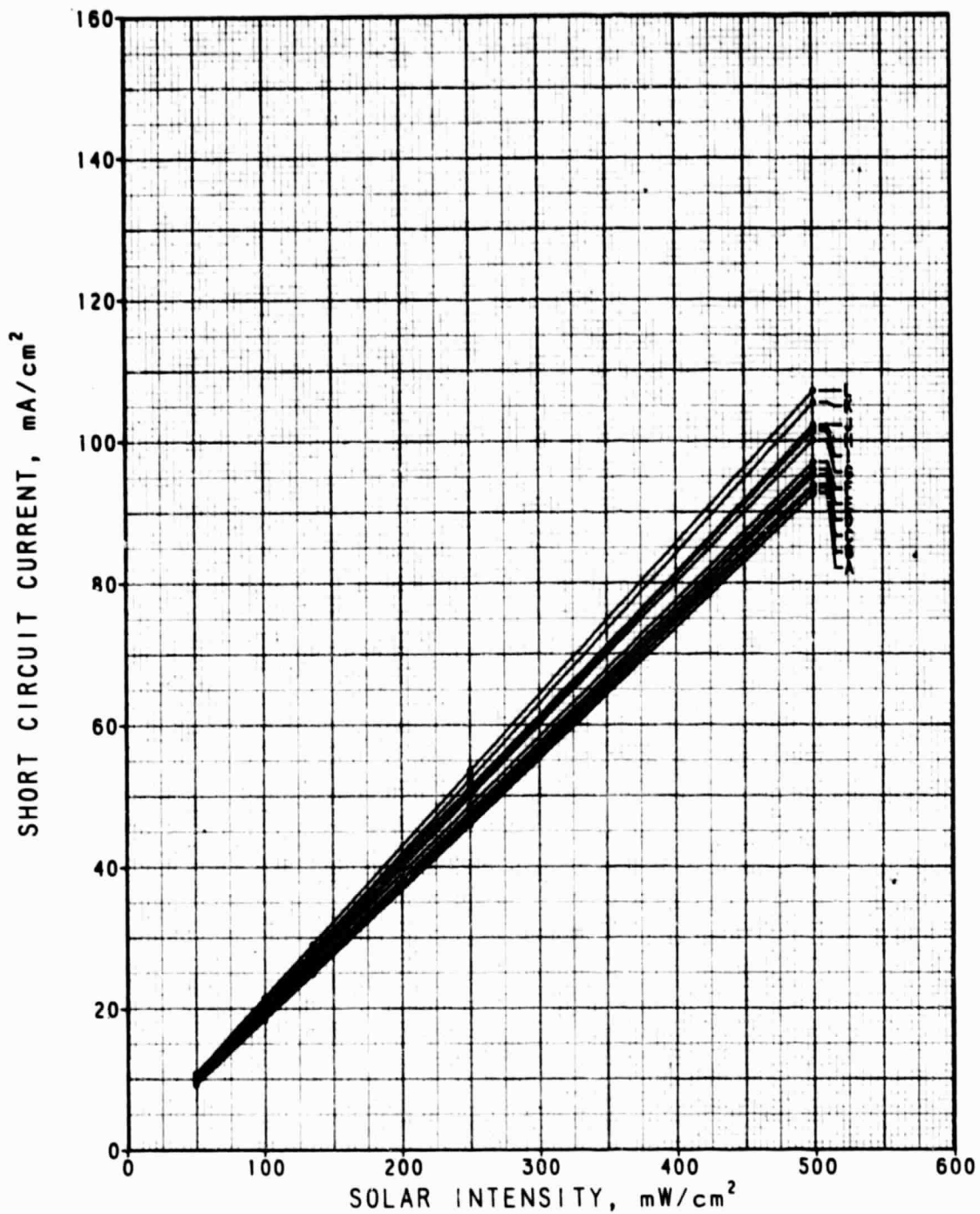


ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 25. Average AMO Efficiency as a Function of Temperature
After 10^{14} electrons/cm²

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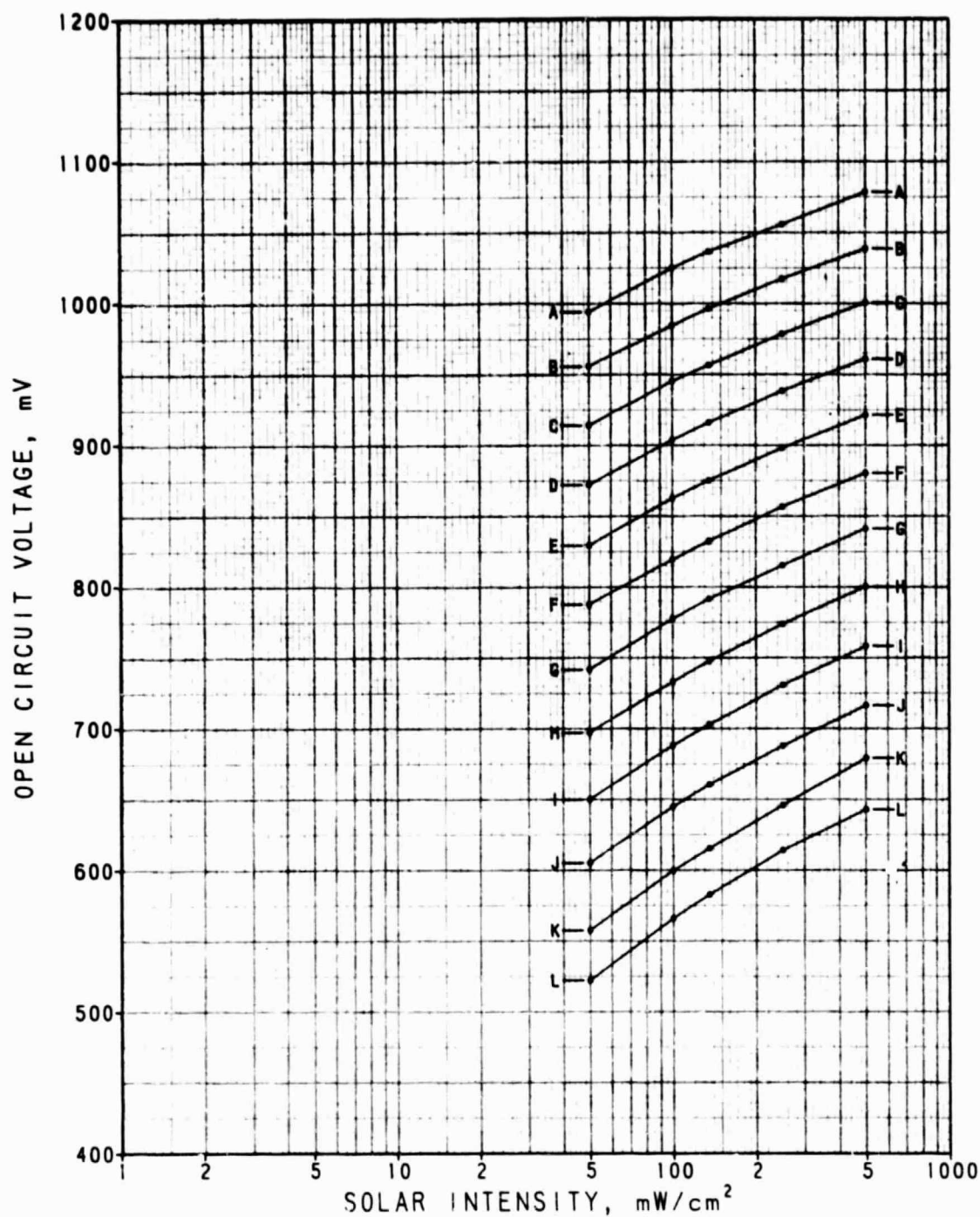


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cmsec2 TM-58

Figure 26. Average I_{sc}/cm^2 as a Function of Intensity
After 10^{14} electrons/cm²

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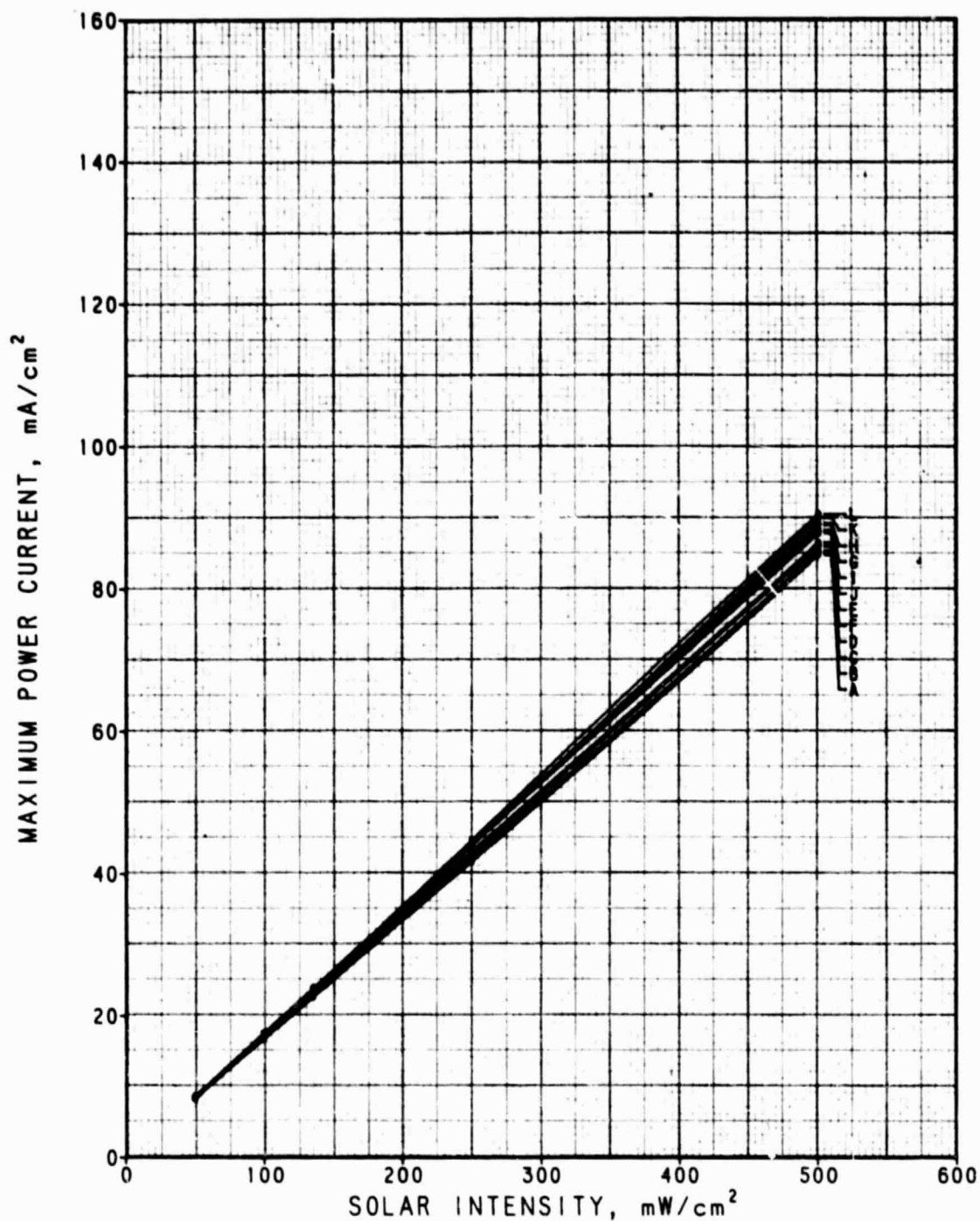


ID	°C	ID	°C
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 27. Average V_{OC} as a Function of Intensity
After 10^{14} electrons/cm²

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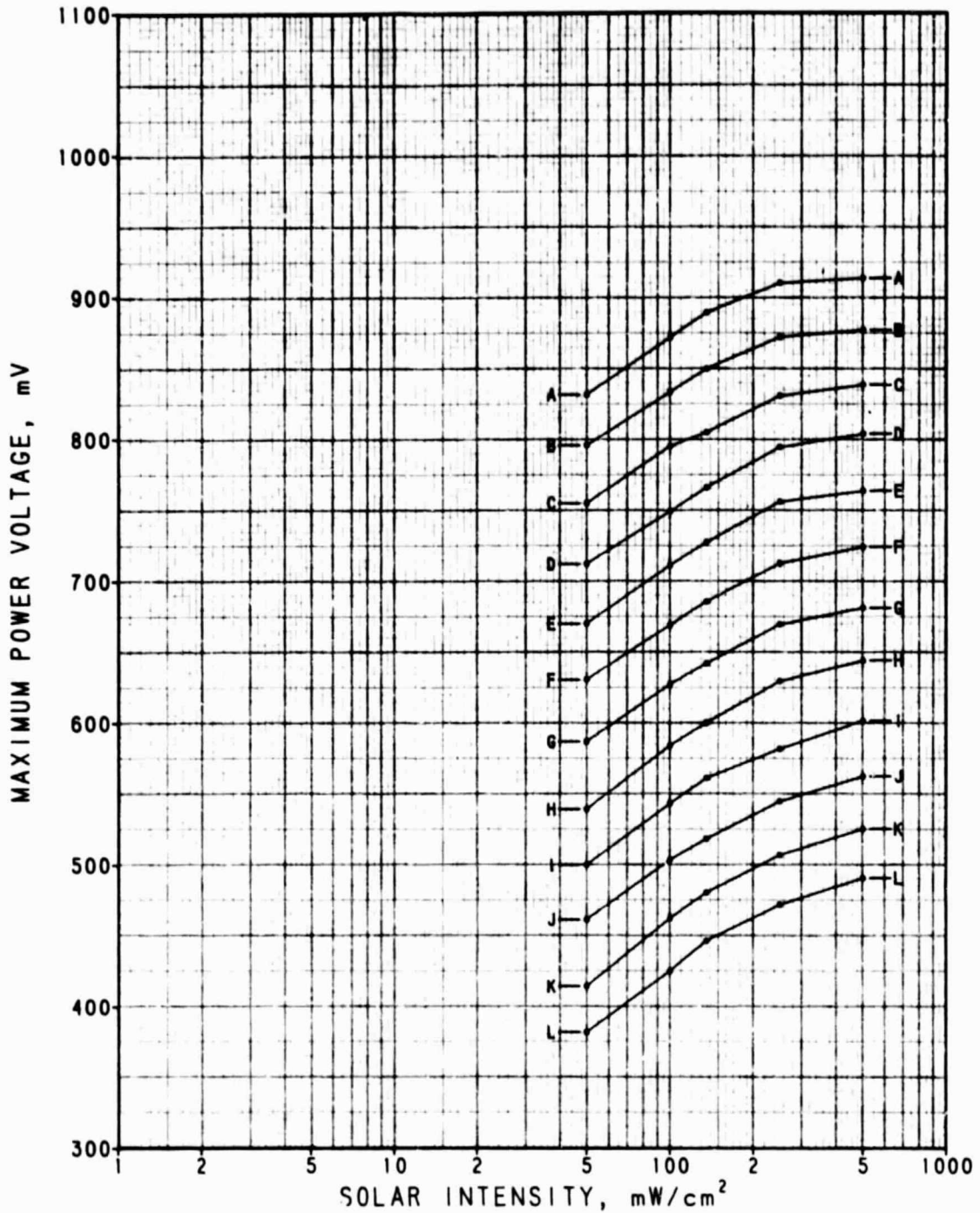


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 28. Average I_{mp}/cm^2 as a Function of Intensity
After 10^{14} electrons/cm²

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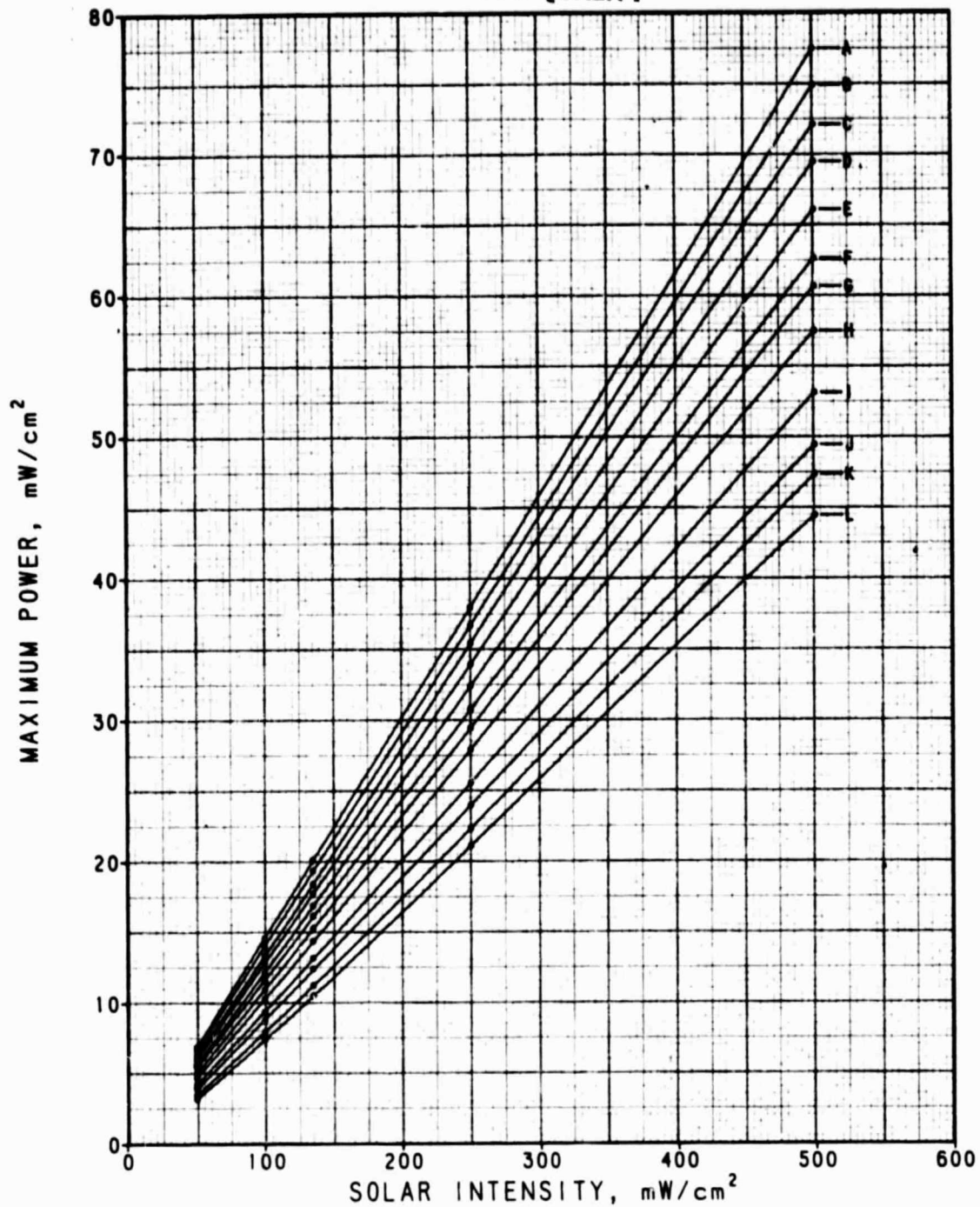


ID	°C	ID	°C
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (NI Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 29. Average V_{mp} as a Function of Intensity
After 10^{14} electrons/cm²

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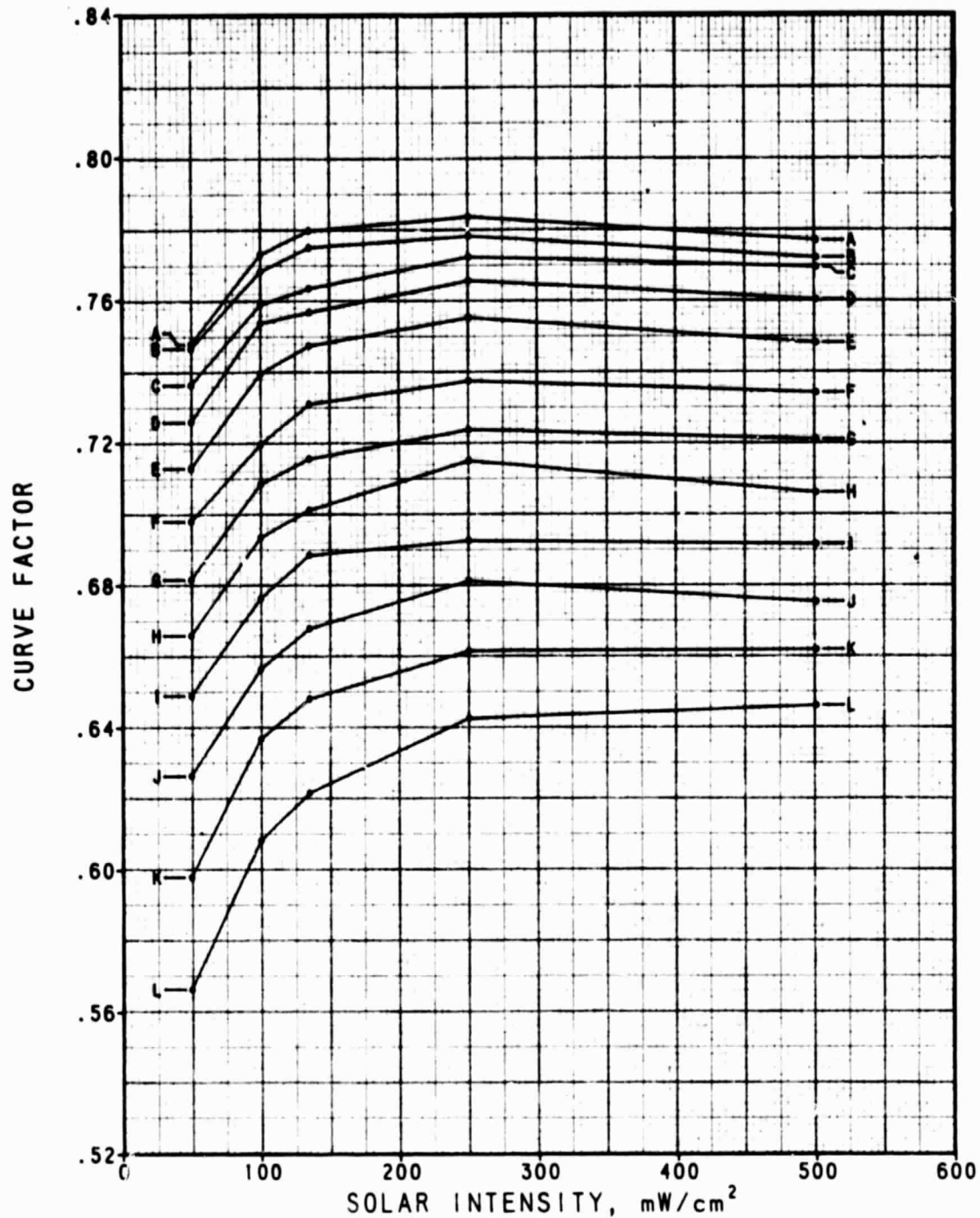


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm²2 TM-58

Figure 30. Average P_{\max}/cm^2 as a Function of Intensity
After 10^{14} electrons/cm²

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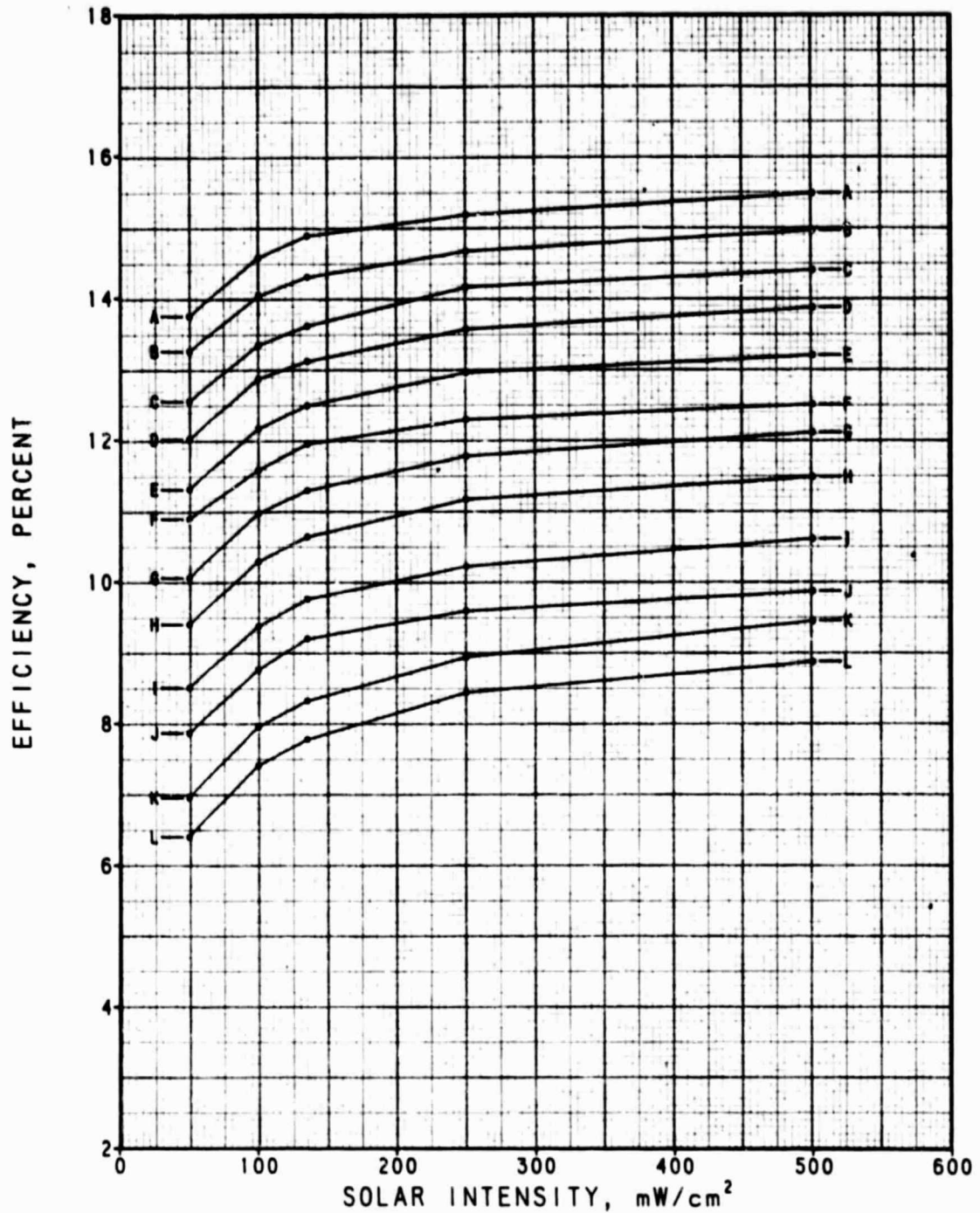


ID	°C	ID	°C
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 31. Average Curve Factor as a Function of Intensity
After 10^{14} electrons/cm²

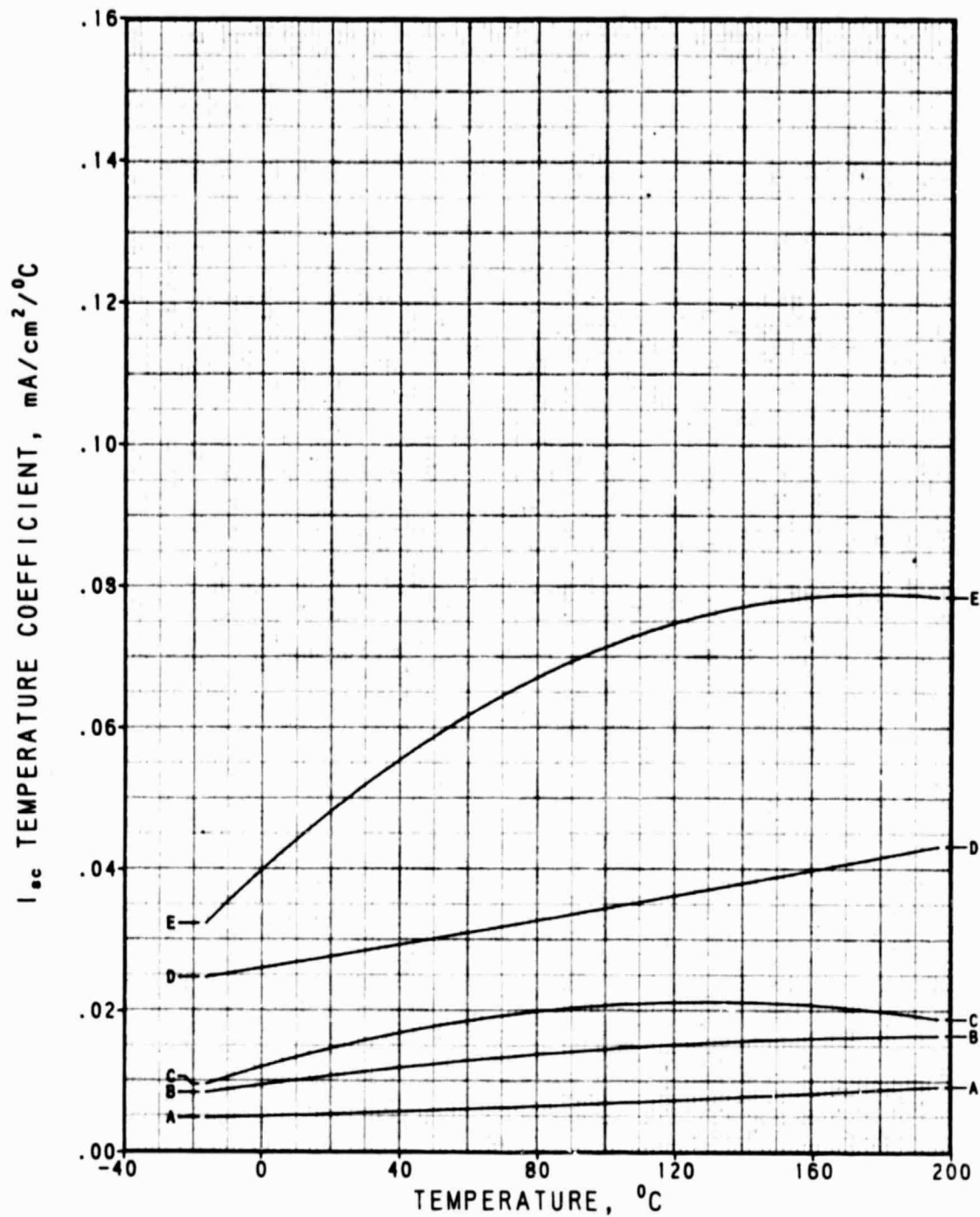
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ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 32. Average AMO Efficiency as a Function of Intensity
After 10^{14} electrons/cm²

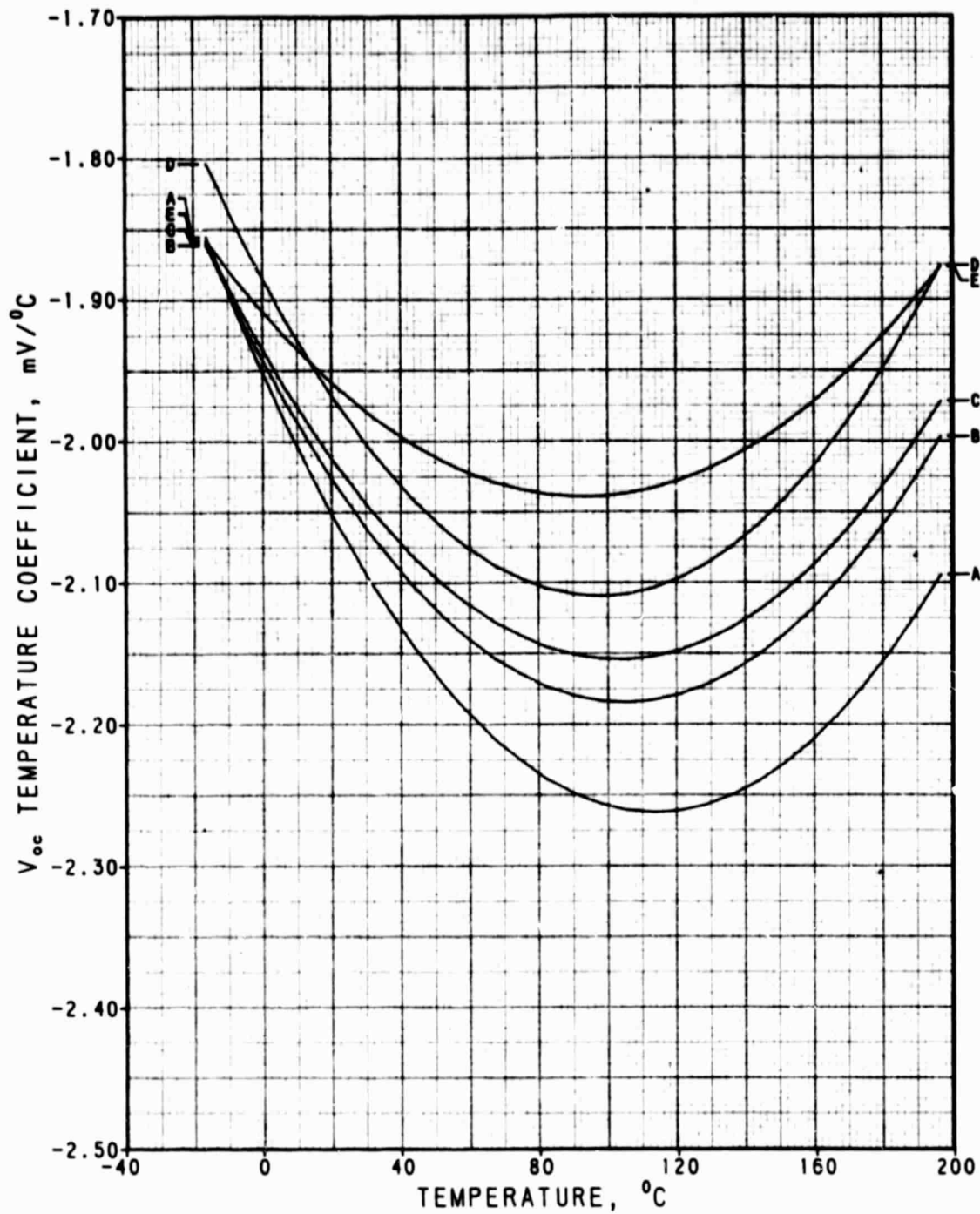


ID	mW/cm²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 33. I_{sc} Temperature Coefficient
After 10^{14} electrons/cm²

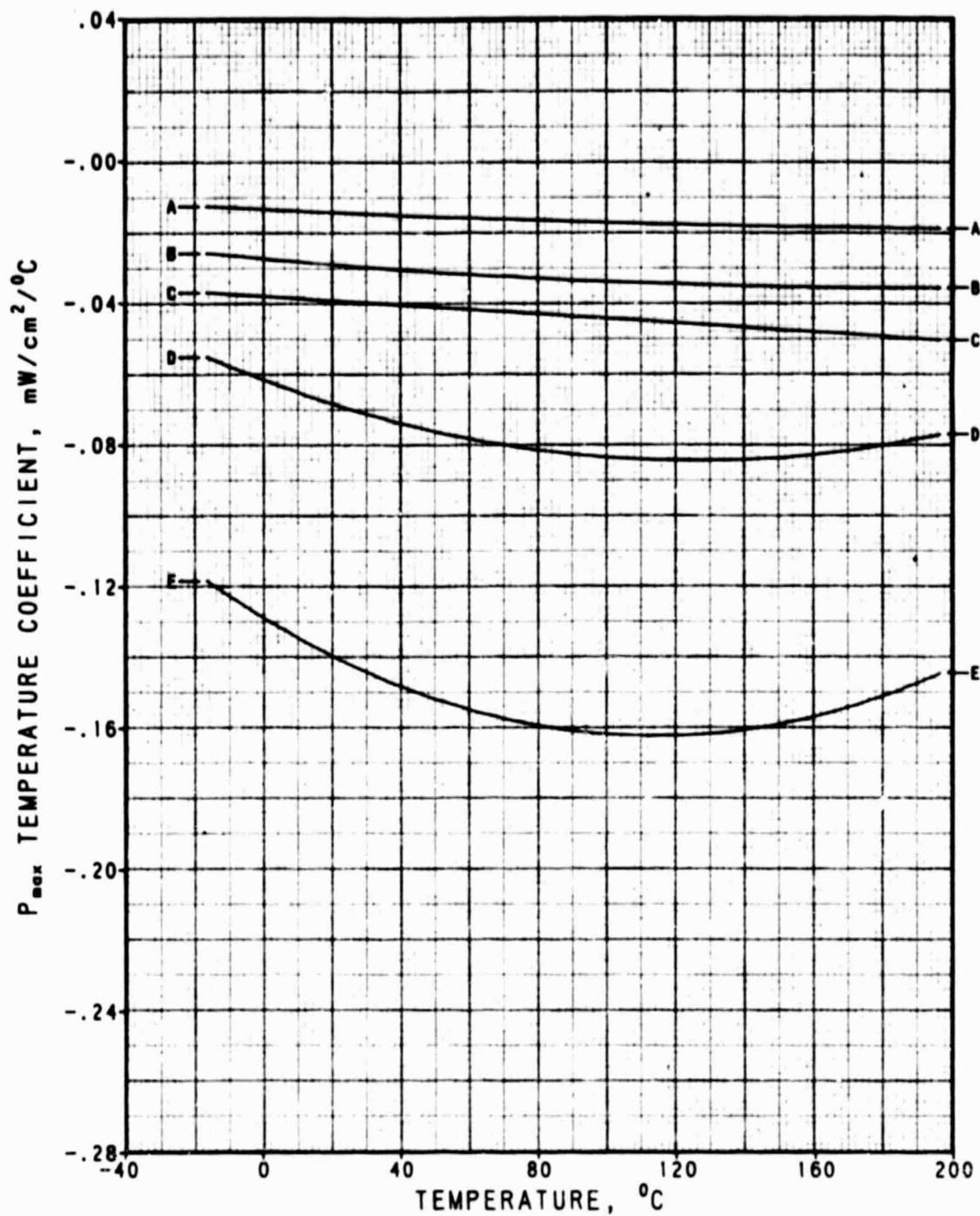
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ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 34. V_{oc} Temperature Coefficient
After 10^{14} electrons/cm²

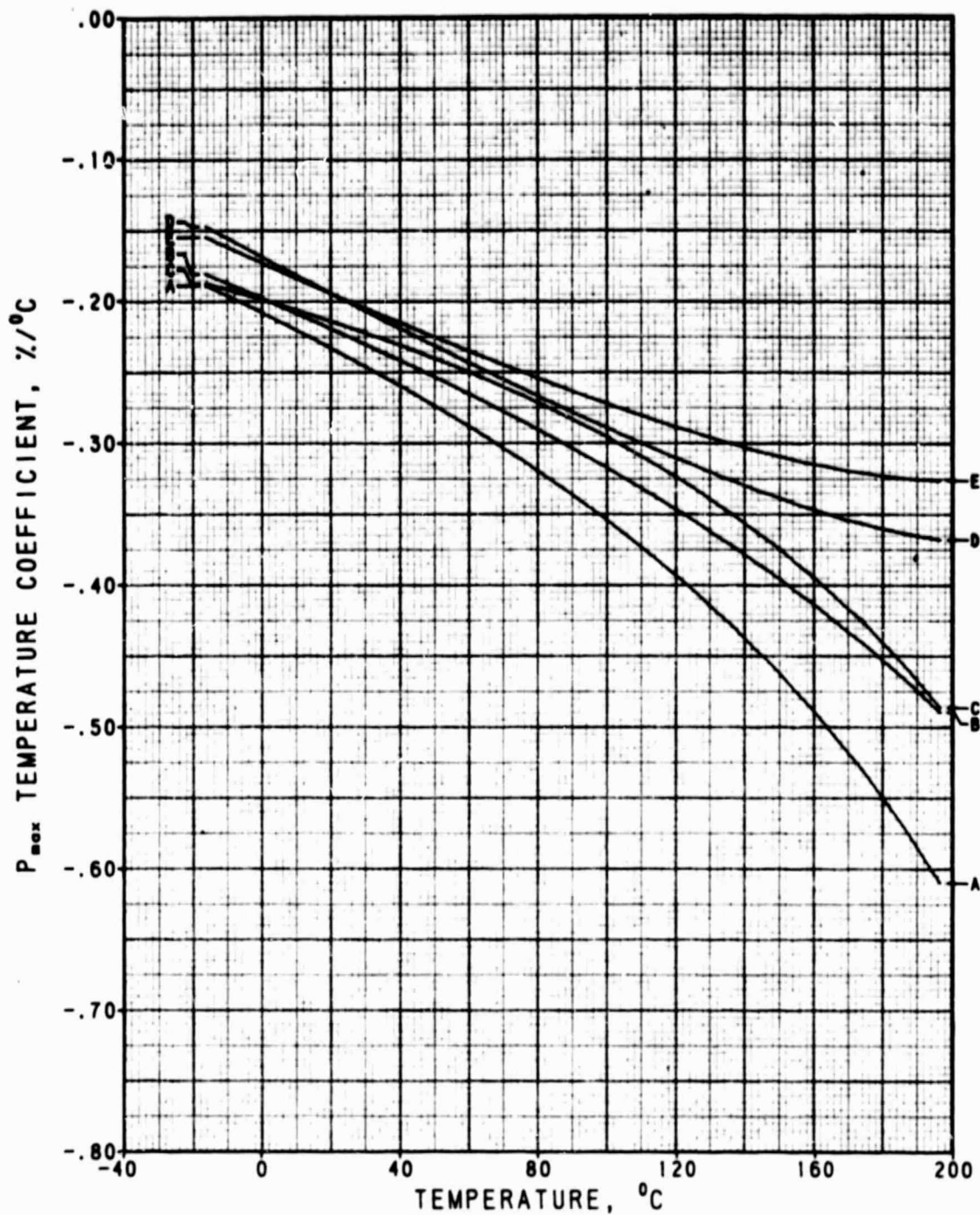


ID	mW/cm^2
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER $1.E14 \text{ e/cm}^2$ TM-58

Figure 35. Absolute P_{max} Temperature Coefficient
After 10^{14} electrons/ cm^2

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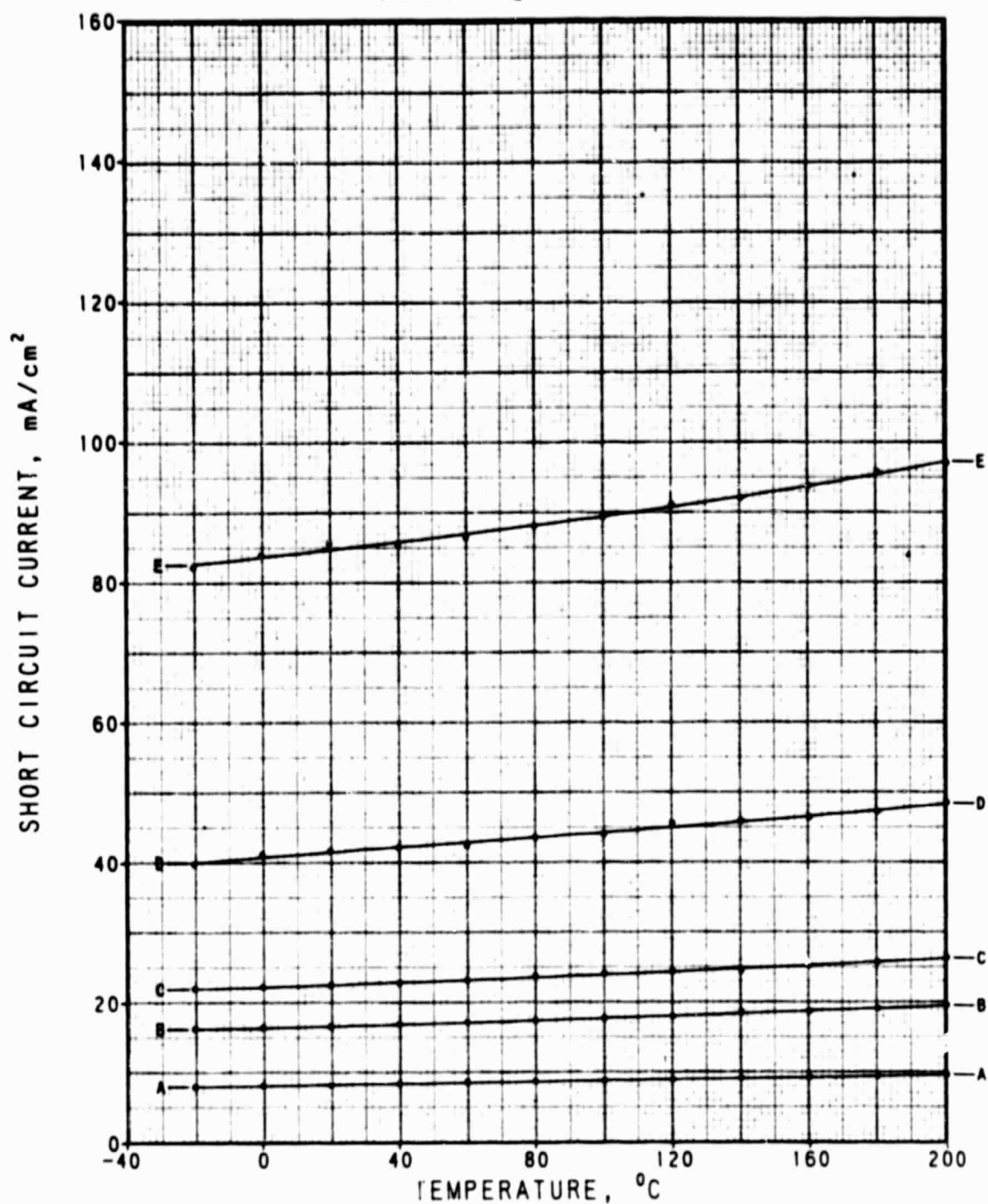


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E14 e/cm² TM-58

Figure 36. Percent P_{max} Temperature Coefficient
After 10^{14} electrons/cm²

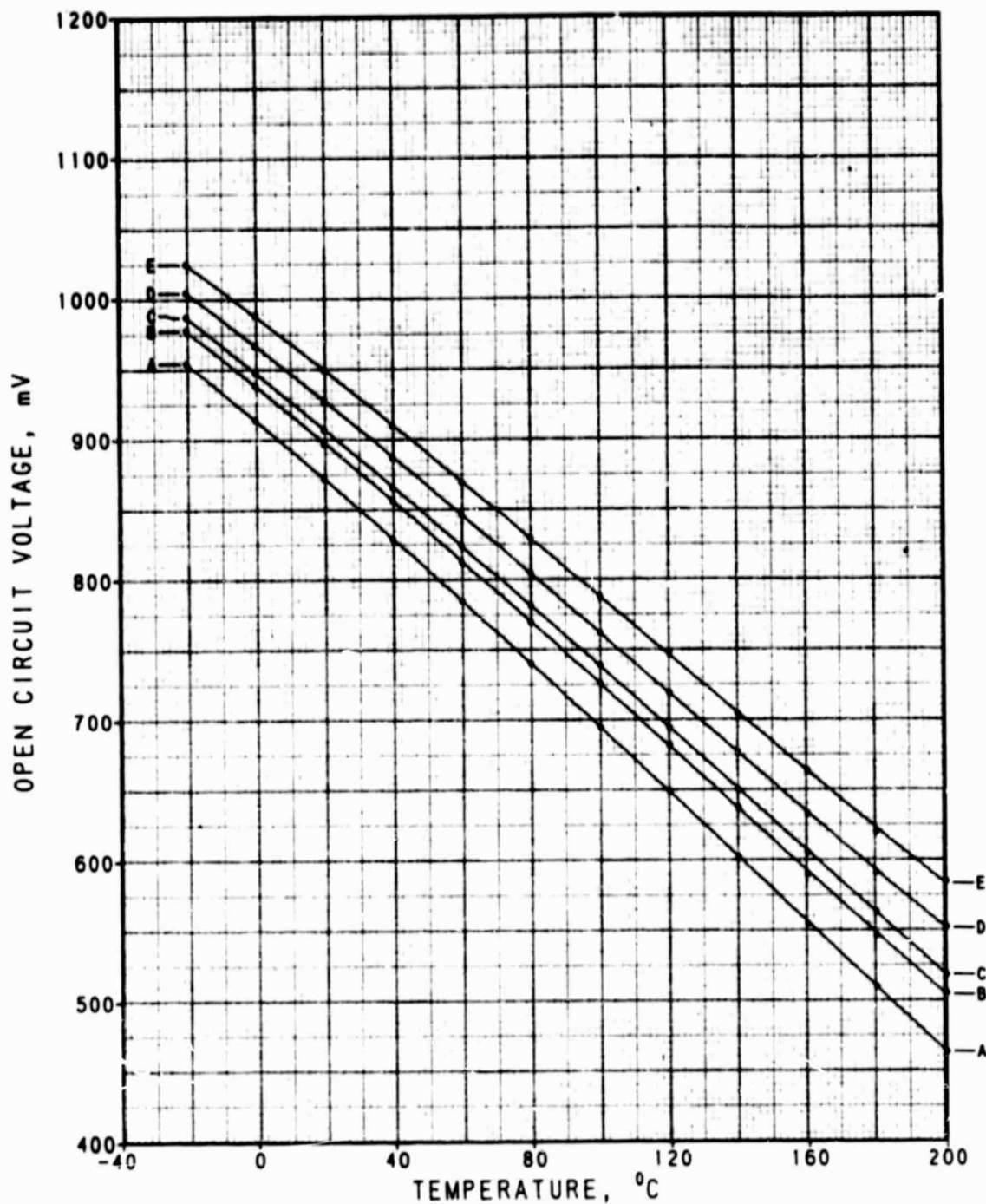
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ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 37. Average I_{sc}/cm^2 as a Function of Temperature
After 10^{15} electrons/cm²



ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 38. Average V_{oc} as a Function of Temperature
After 10^{15} electrons/cm²

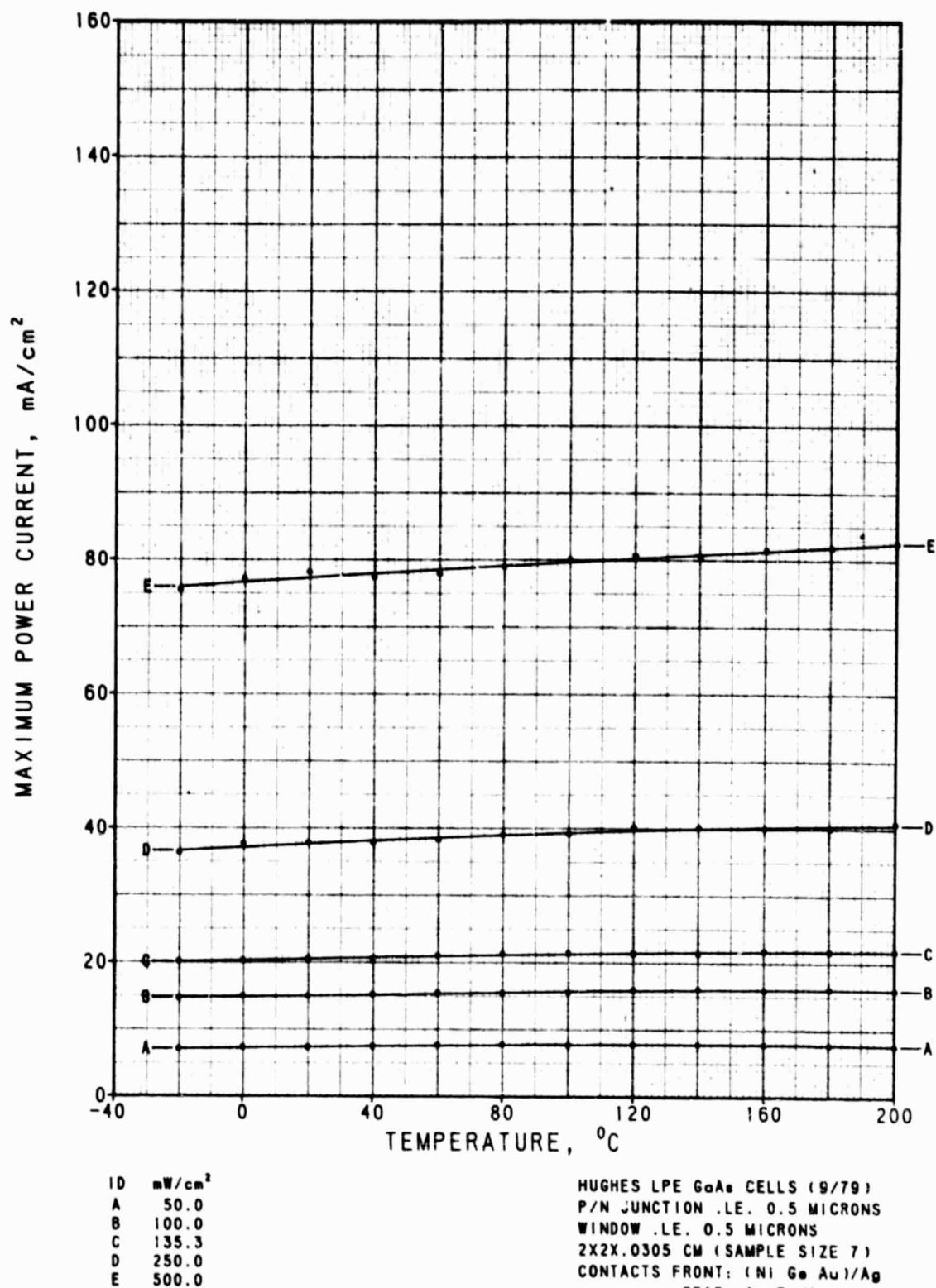
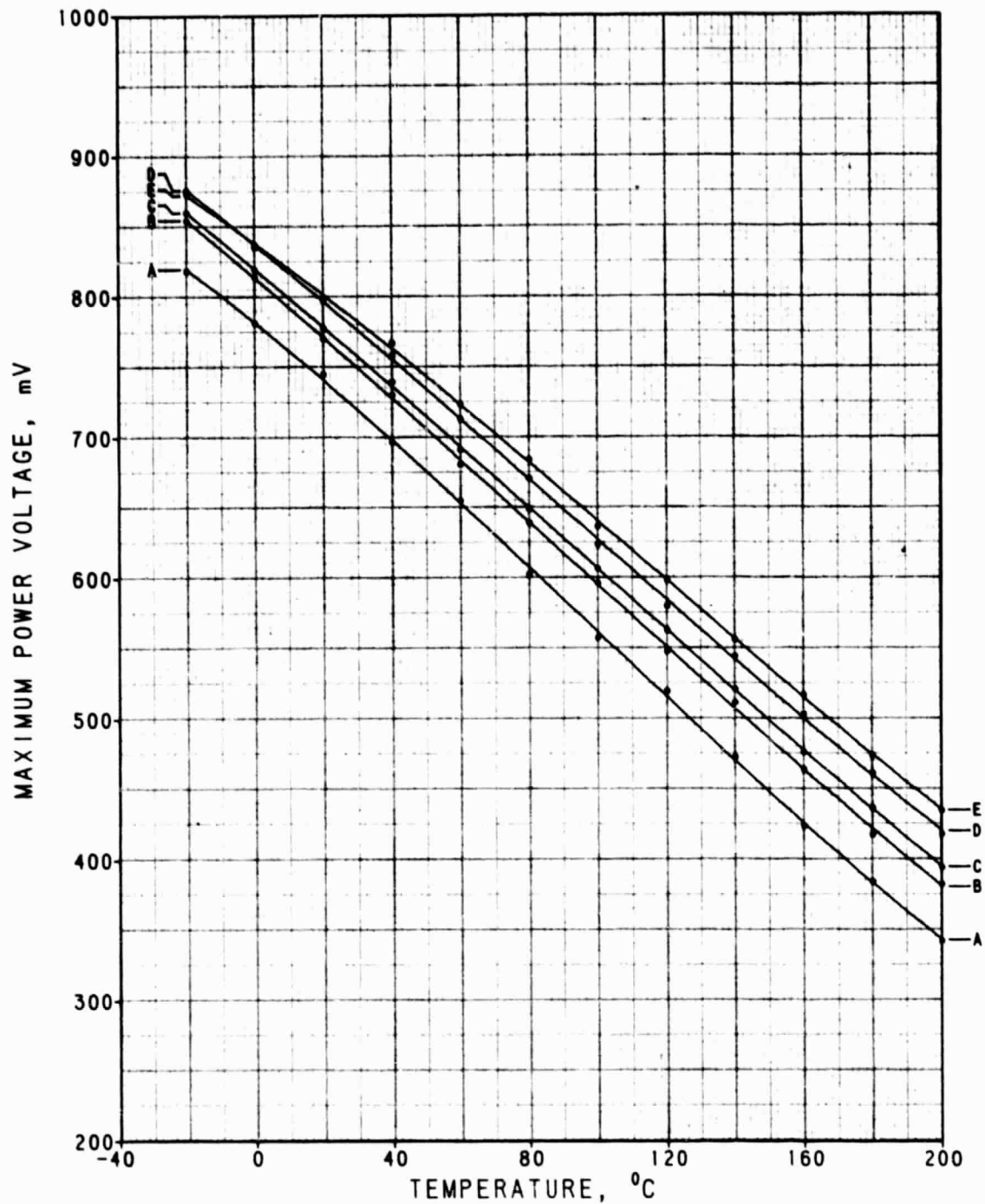


Figure 39. Average I_{mp}/cm^2 as a Function of Temperature
After 10^{15} electrons/cm²

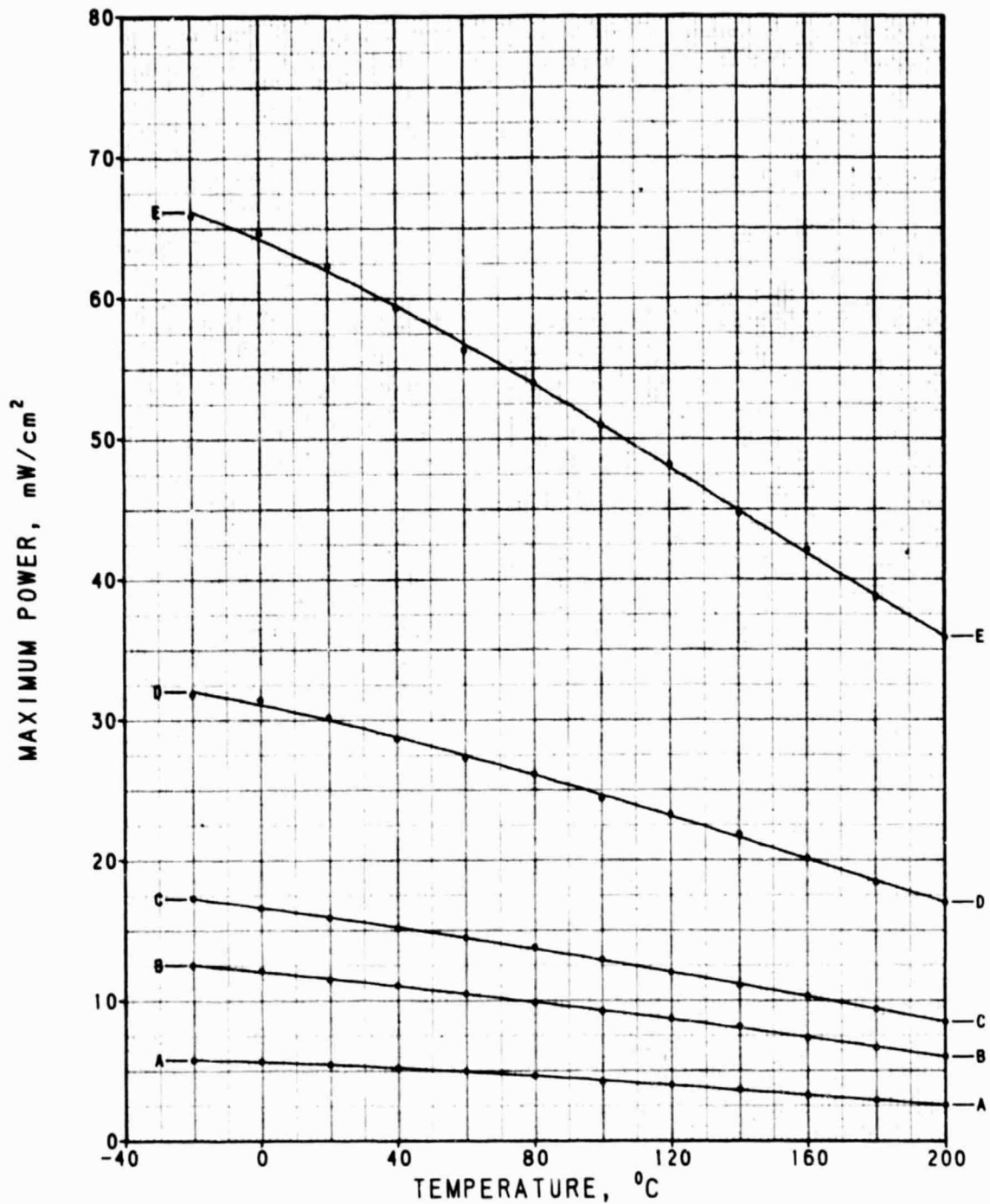
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ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 40. Average V_{mp} as a Function of Temperature
After 10^{15} electrons/cm²

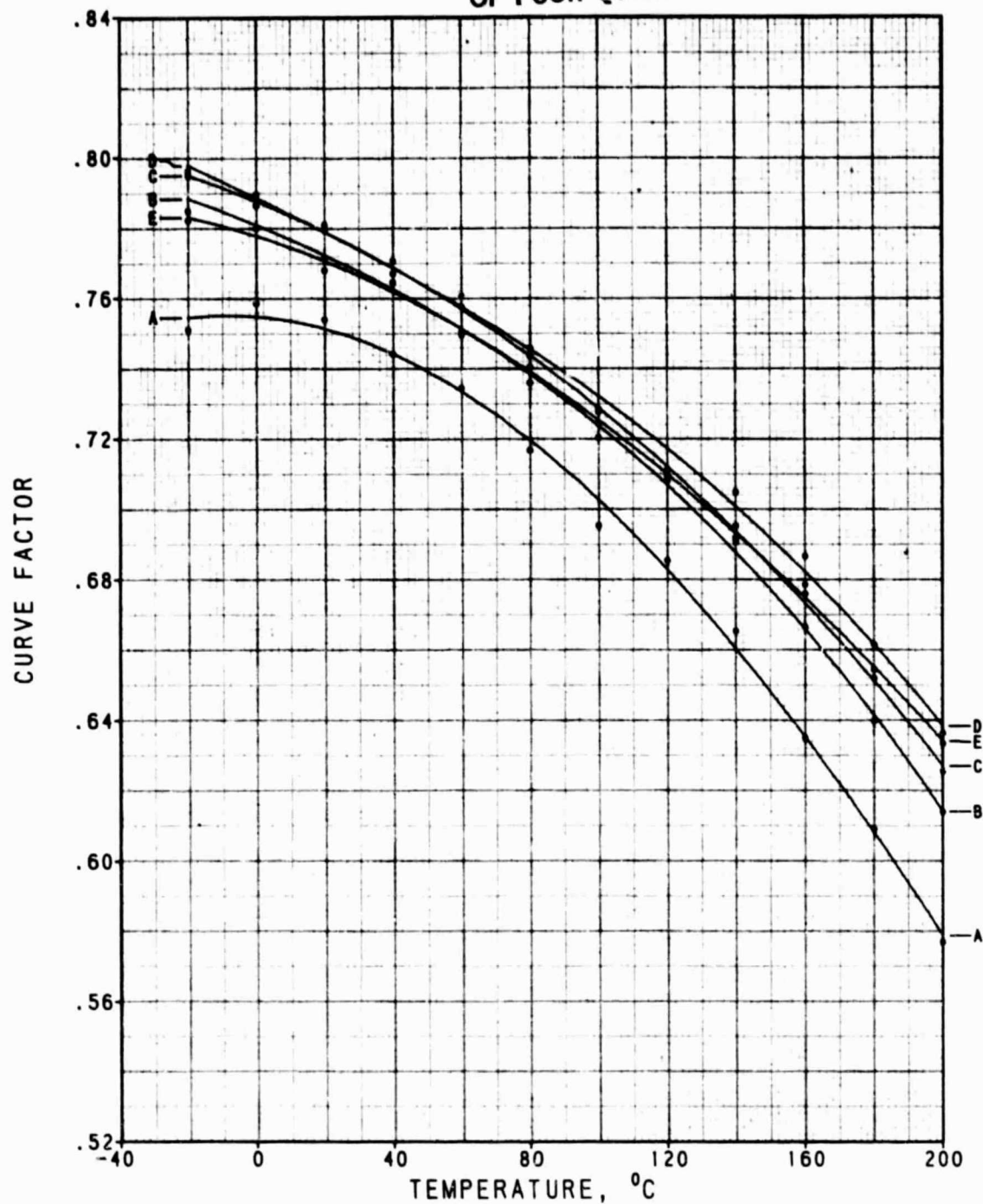


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 41. Average P_{\max}/cm^2 as a Function of Temperature
After 10^{15} electrons/cm²

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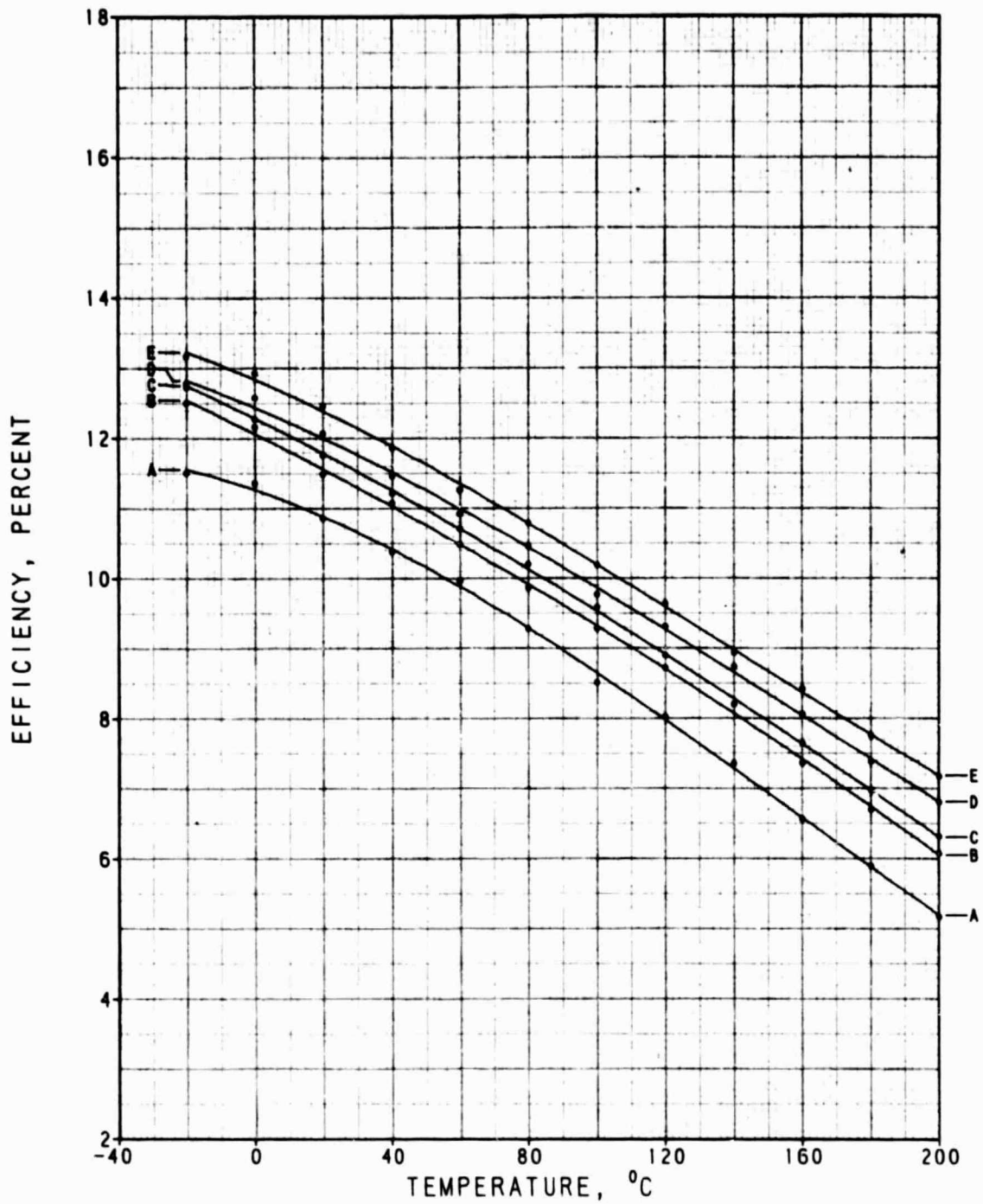


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 42. Average Curve Factor as a Function of Temperature
After 10^{15} electrons/cm²

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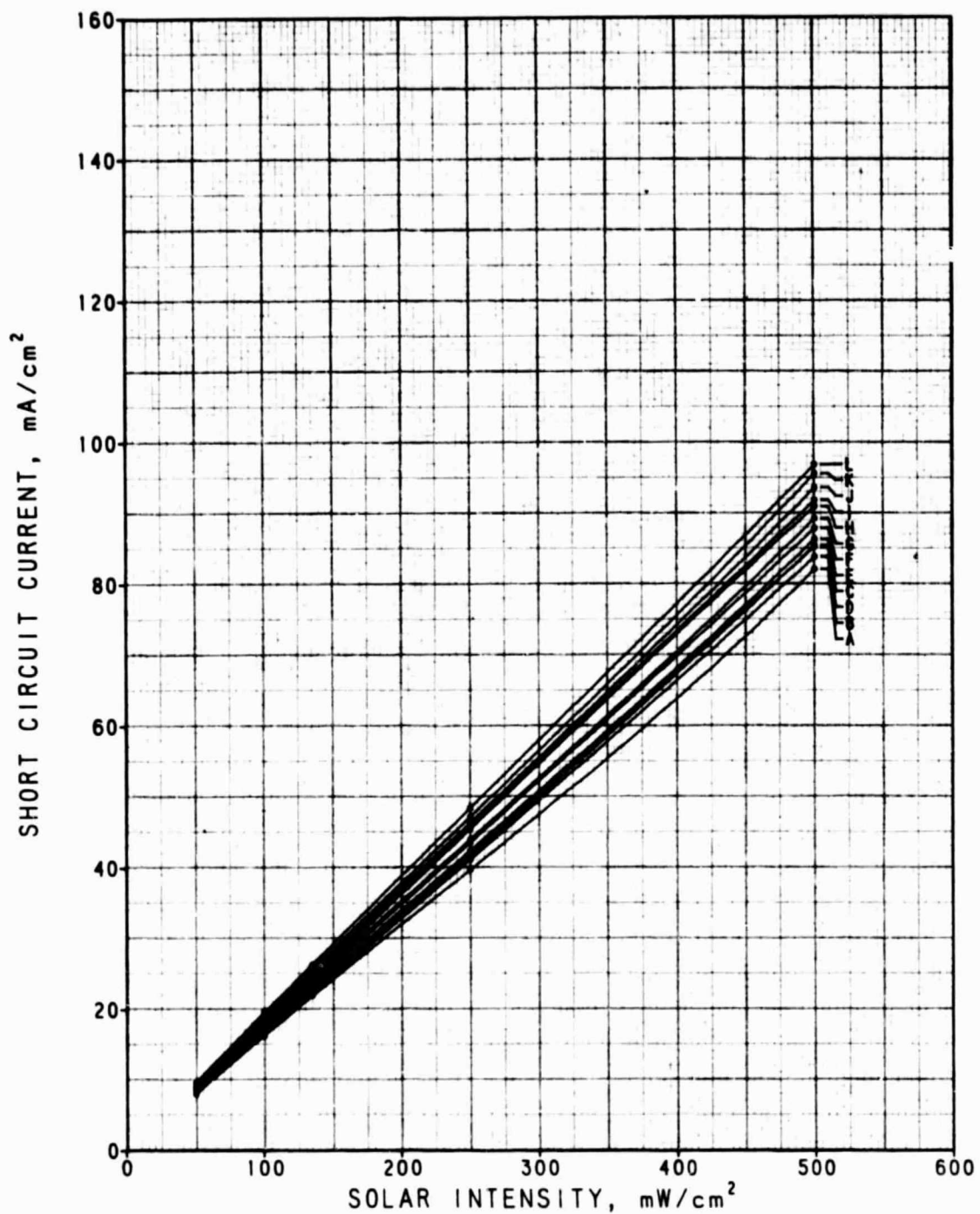


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 43. Average AMO Efficiency as a Function of Temperature
After 10^{15} electrons/cm²

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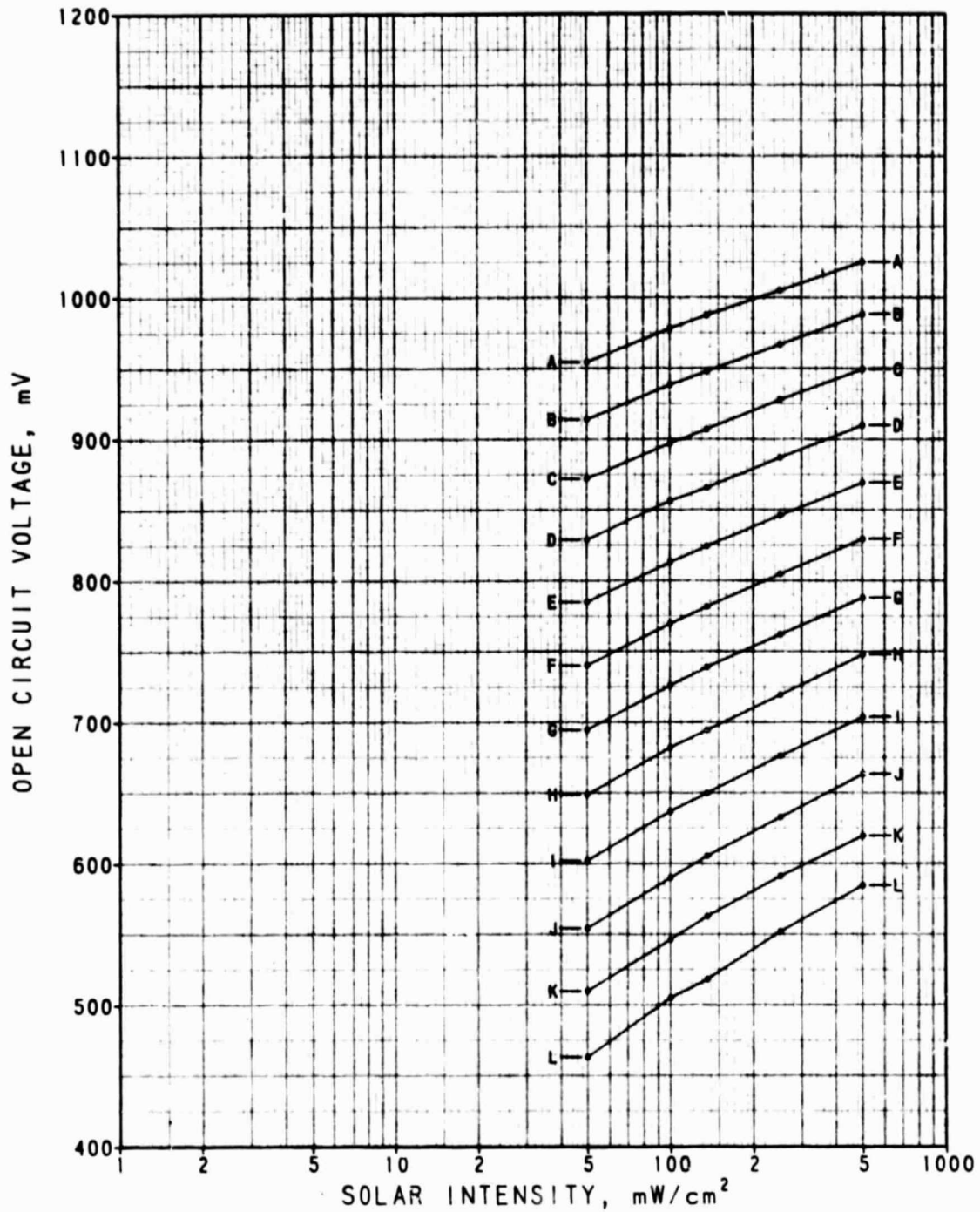


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 44. Average I_{sc}/cm^2 as a Function of Intensity
After 10^{15} electrons/cm²

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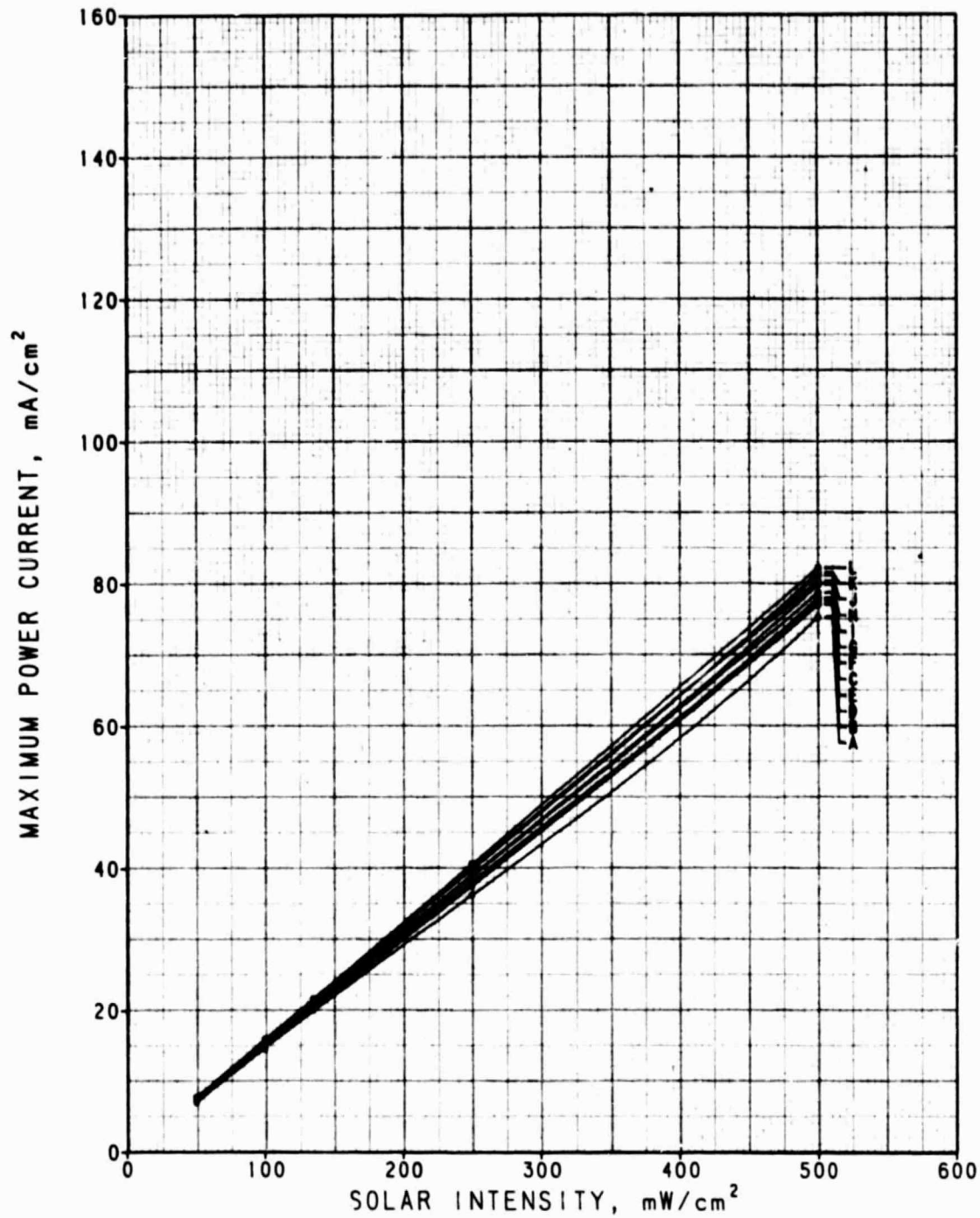


ID	°C	ID	°C
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 45. Average V_{oc} as a Function of Intensity
After 10^{15} electrons/cm²

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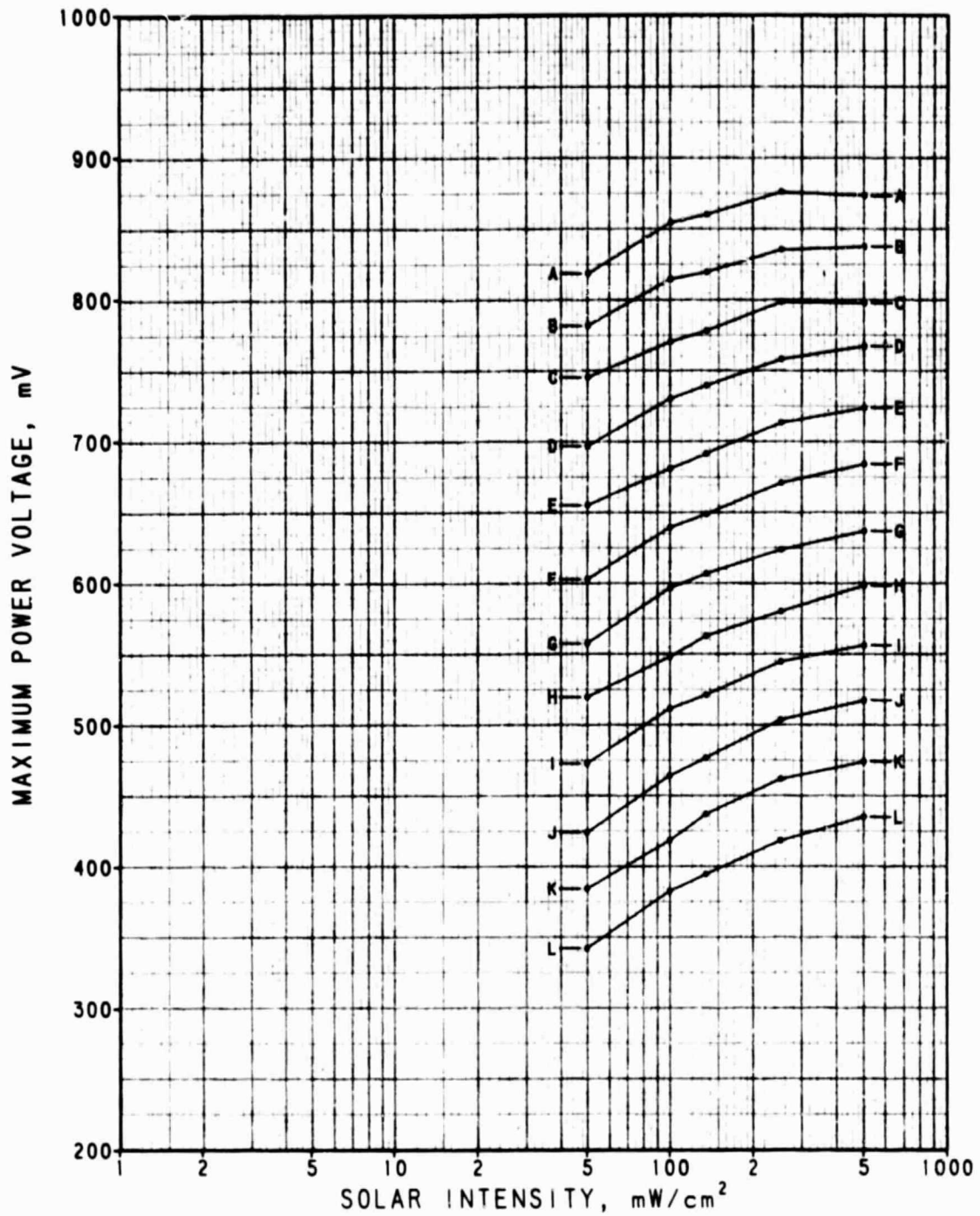


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 46. Average I_{mp}/cm^2 as a Function of Intensity
After 10^{15} electrons/cm²

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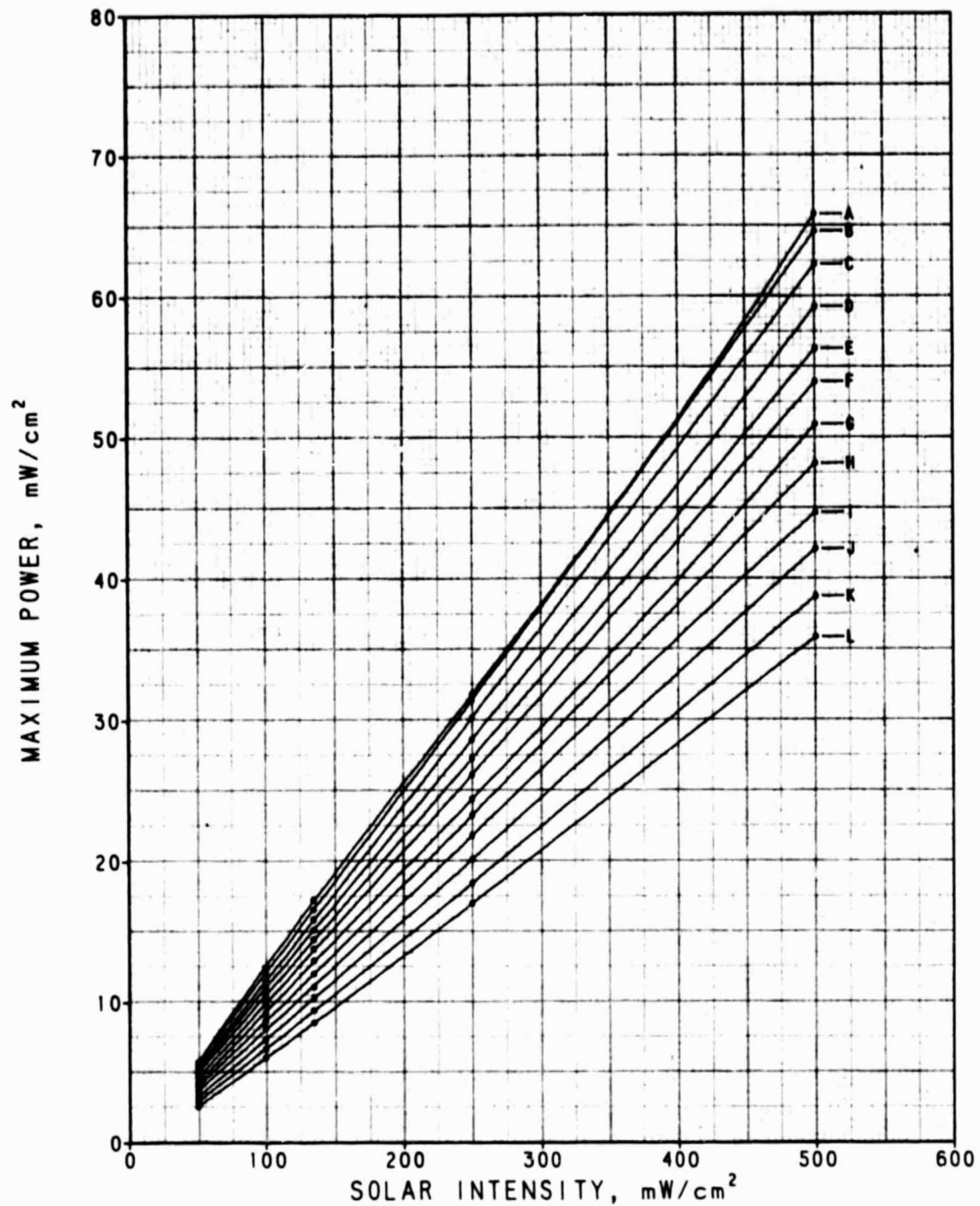


ID	°C	ID	°C
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .1E. 0.5 MICRONS
WINDOW .1E. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (NI Ge Au)/Ag
REAR: Au-Zn/Ag
Tc205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm²2 TM-58

Figure 47. Average V_{mp} as a Function of Intensity
After 10^{15} electrons/cm²

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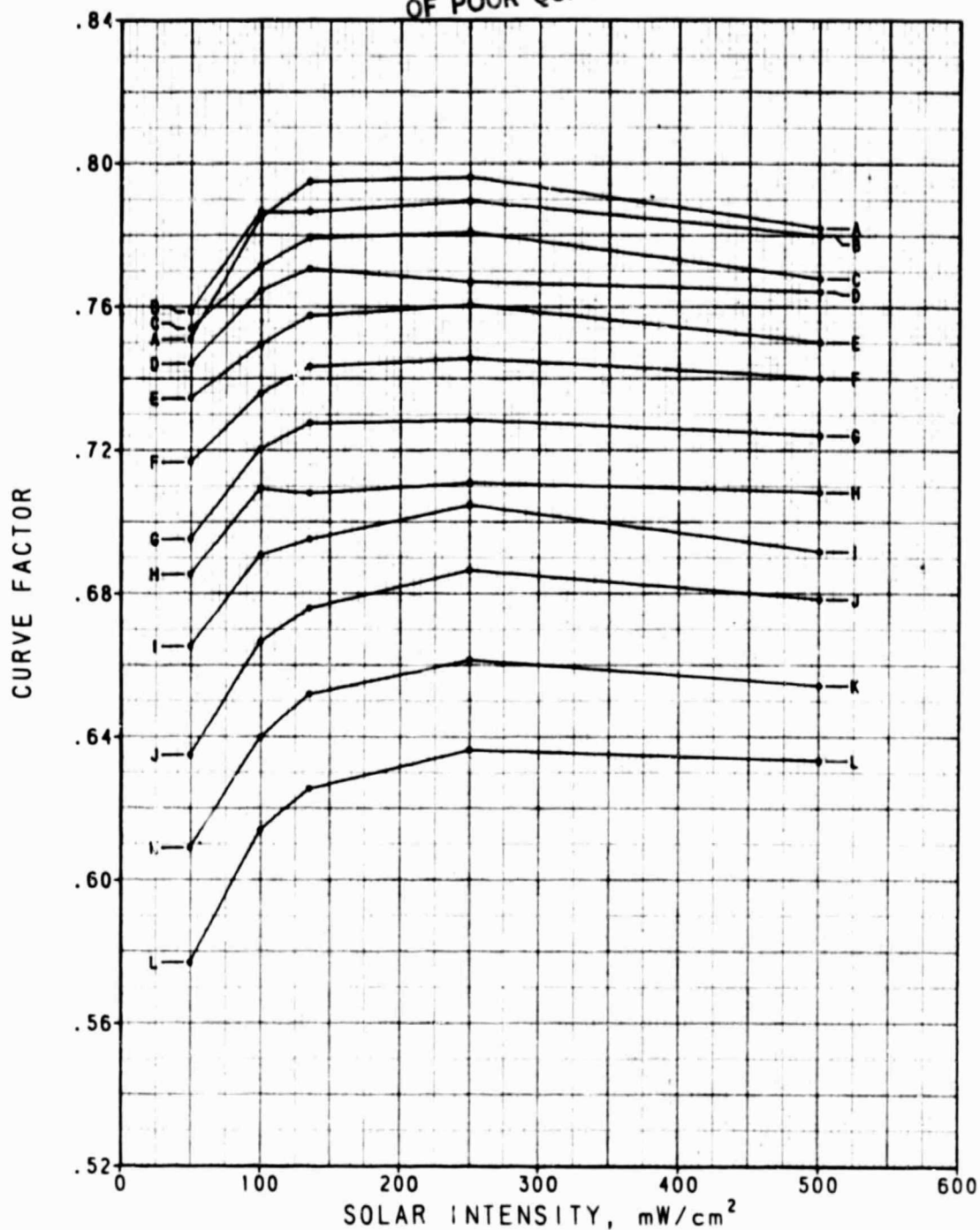


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
T₀205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 48. Average P_{\max}/cm^2 as a Function of Intensity
After 10^{15} electrons/cm²

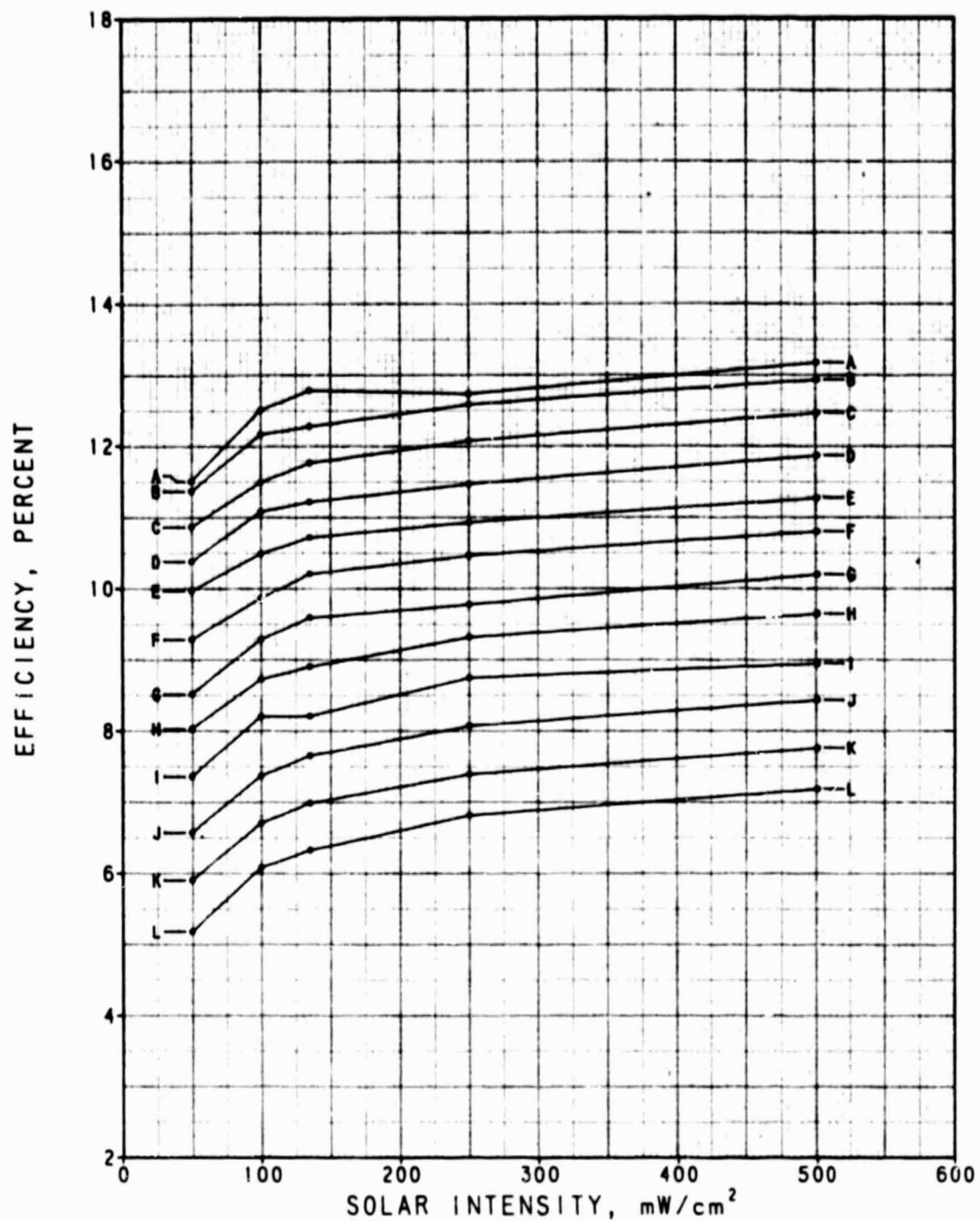
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ID	°C	ID	°C
A	-20.0	I	140.0
B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 49. Average Curve Factor as a Function of Intensity
After 10^{15} electrons/cm²

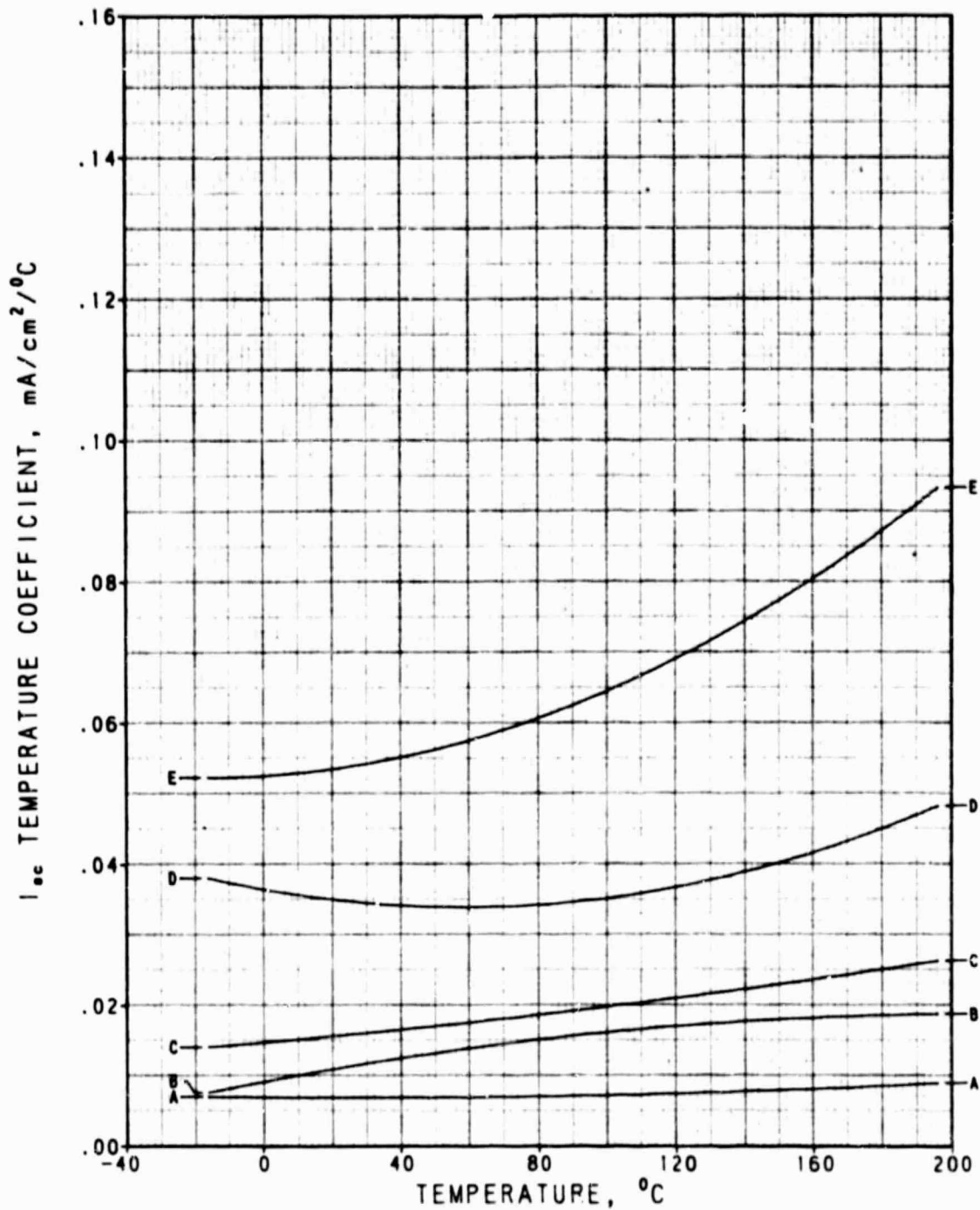


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 50. Average AMO Efficiency as a Function of Intensity
After 10^{15} electrons/cm²

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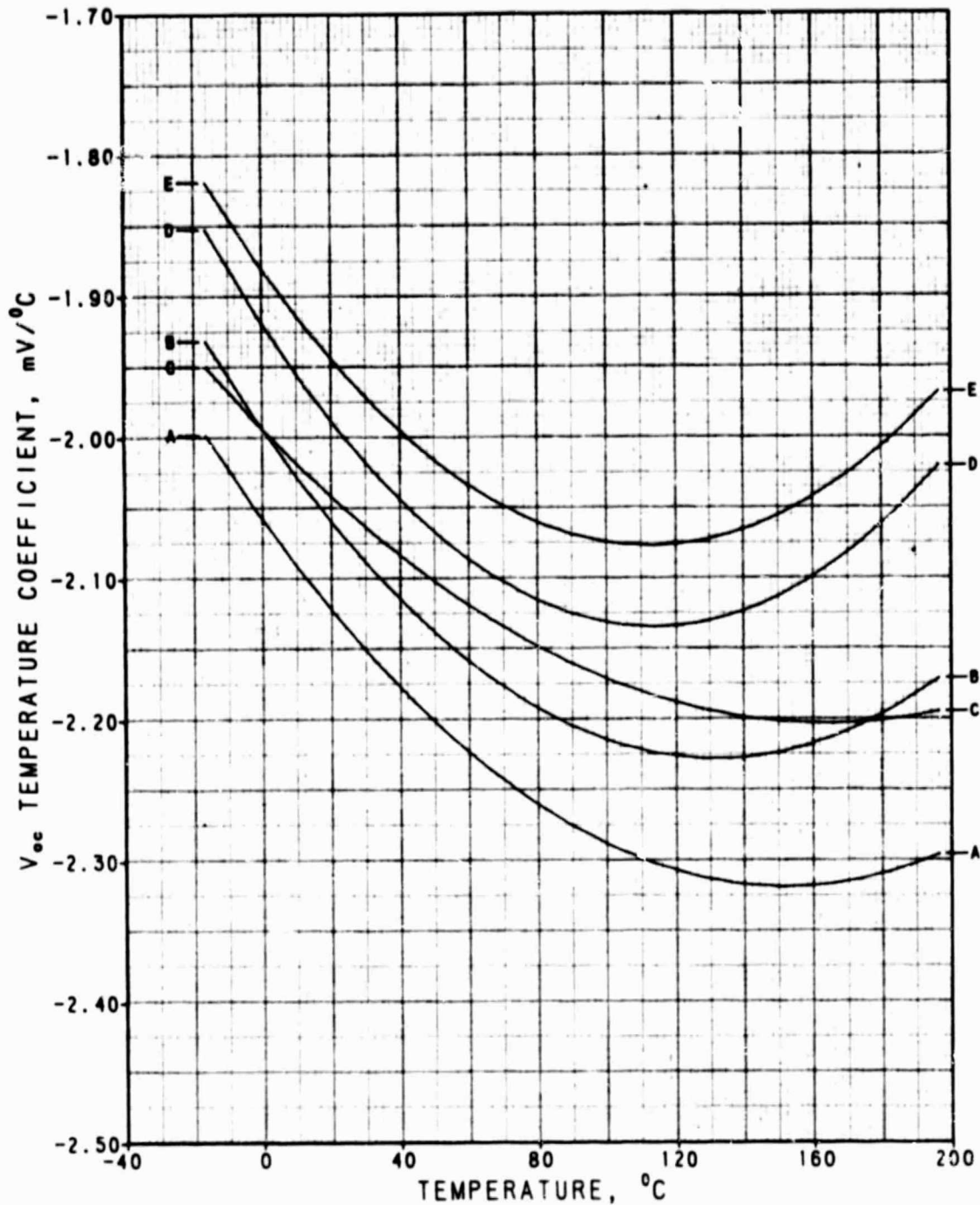


ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cmsec2 TM-58

Figure 51. I_{sc} Temperature Coefficient
After 10^{15} electrons/cm²

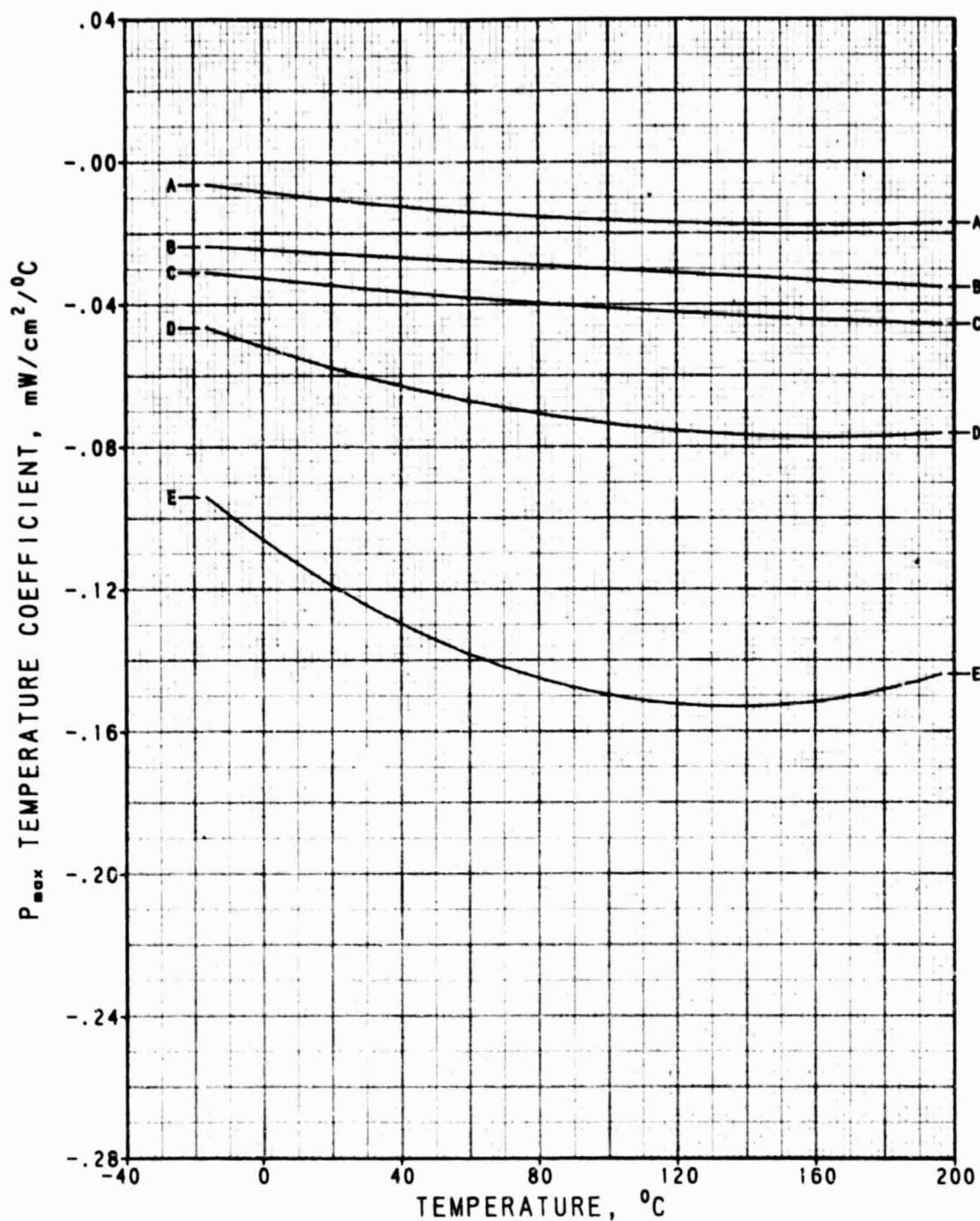
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ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 52. V_{oc} Temperature Coefficient
After 10^{15} electrons/cm²

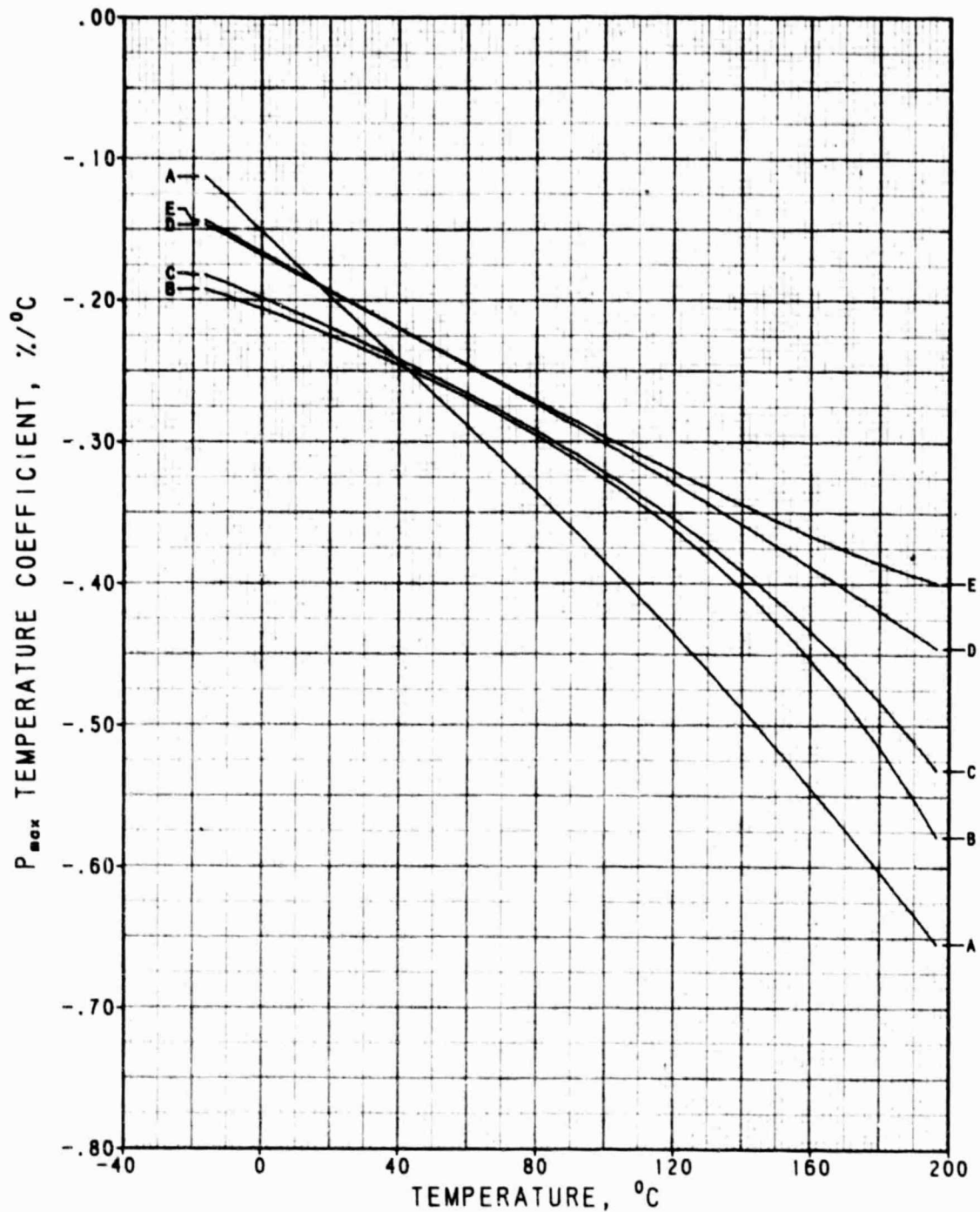


ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta20% A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 53. Absolute P_{max} Temperature Coefficient
After 10^{15} electrons/cm²

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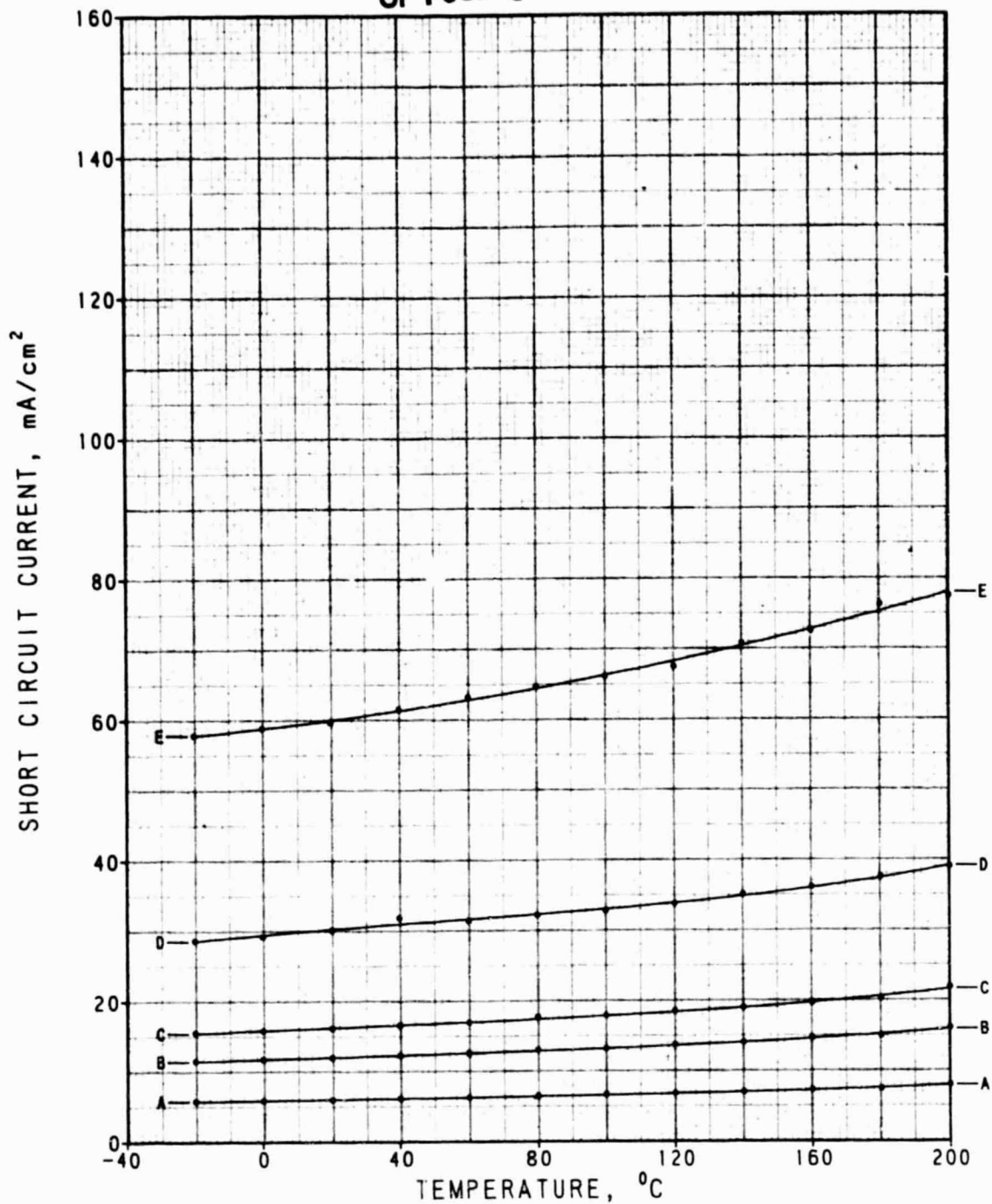


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E15 e/cm² TM-58

Figure 54. Percent P_{max} Temperature Coefficient
After 10^{15} electrons/cm²

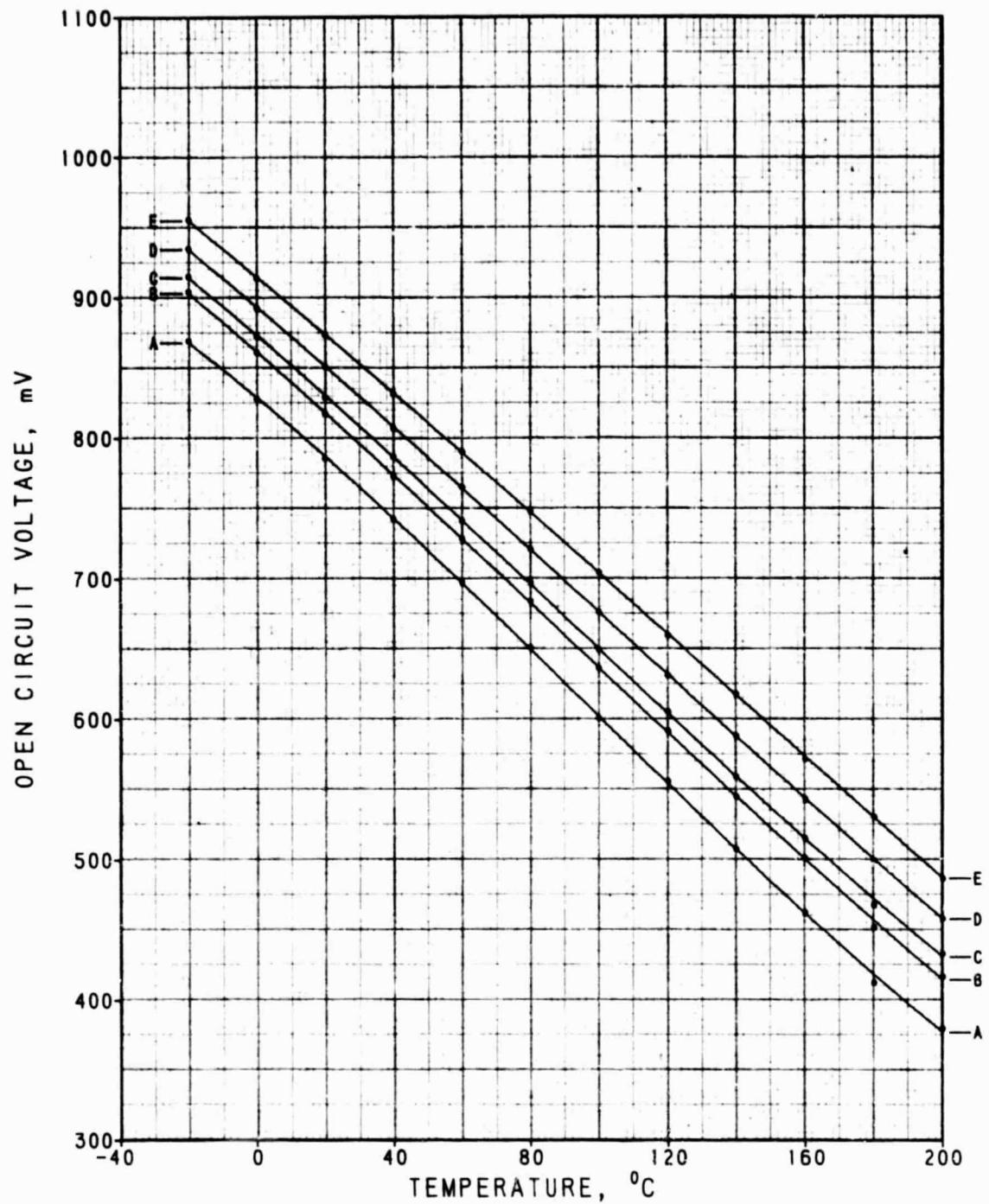
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ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm²2 TM-58

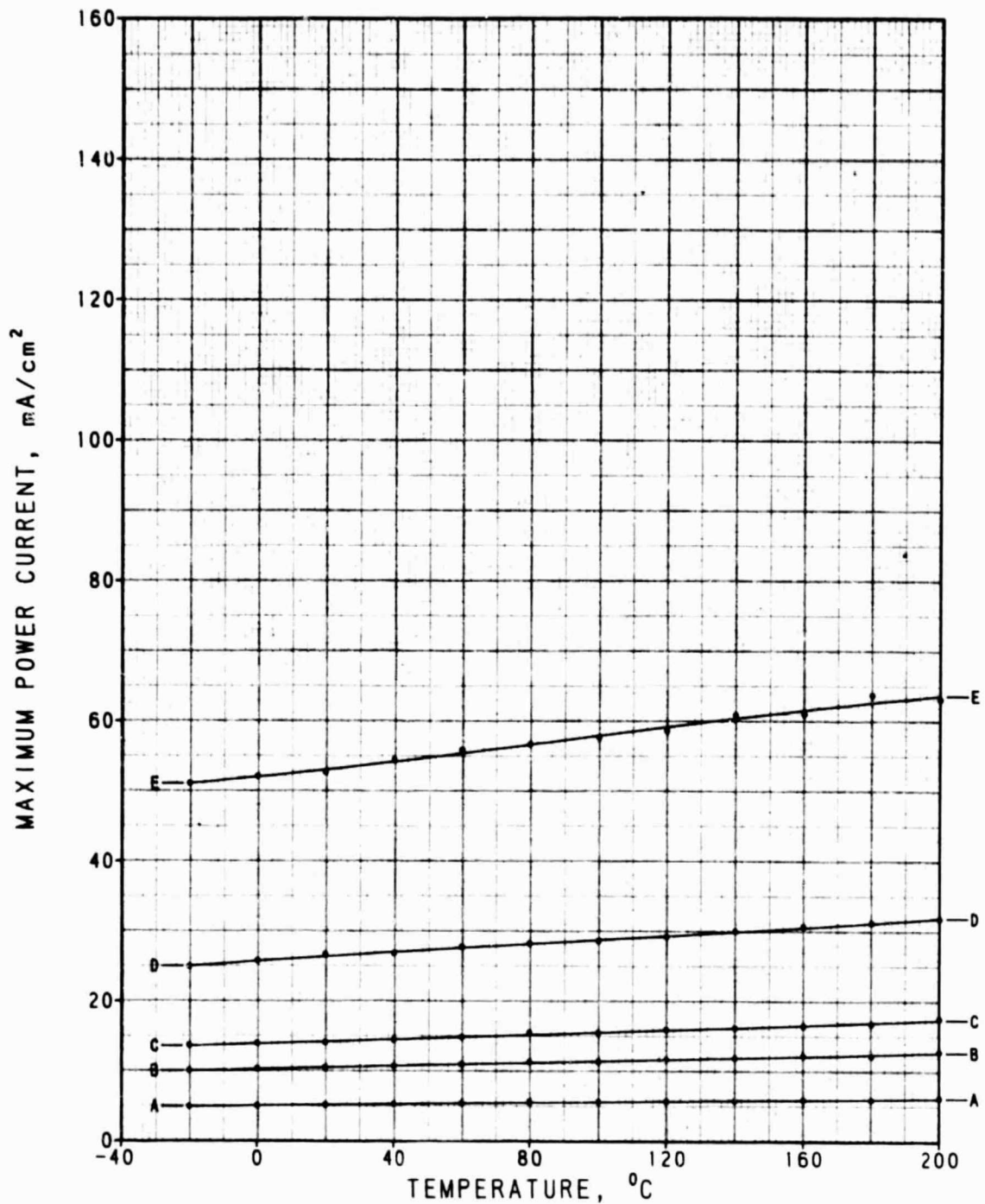
Figure 55. Average I_{sc}/cm^2 as a Function of Temperature
After 10^{16} electrons/cm²



ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 56. Average V_{oc} as a Function of Temperature
After 10^{16} electrons/cm²

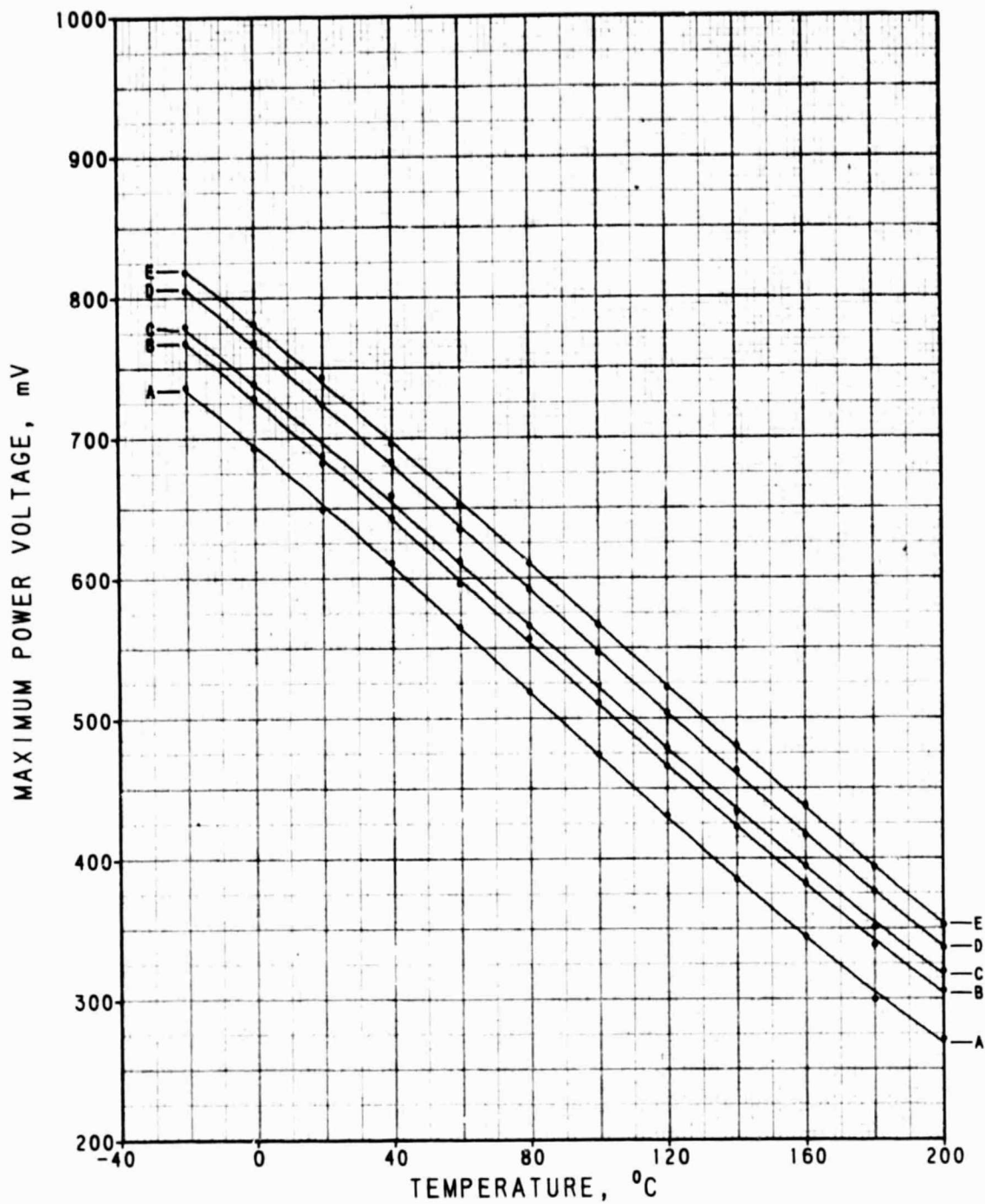


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 57. Average I_{mp}/cm^2 as a Function of Temperature
After 10^{16} electrons/cm²

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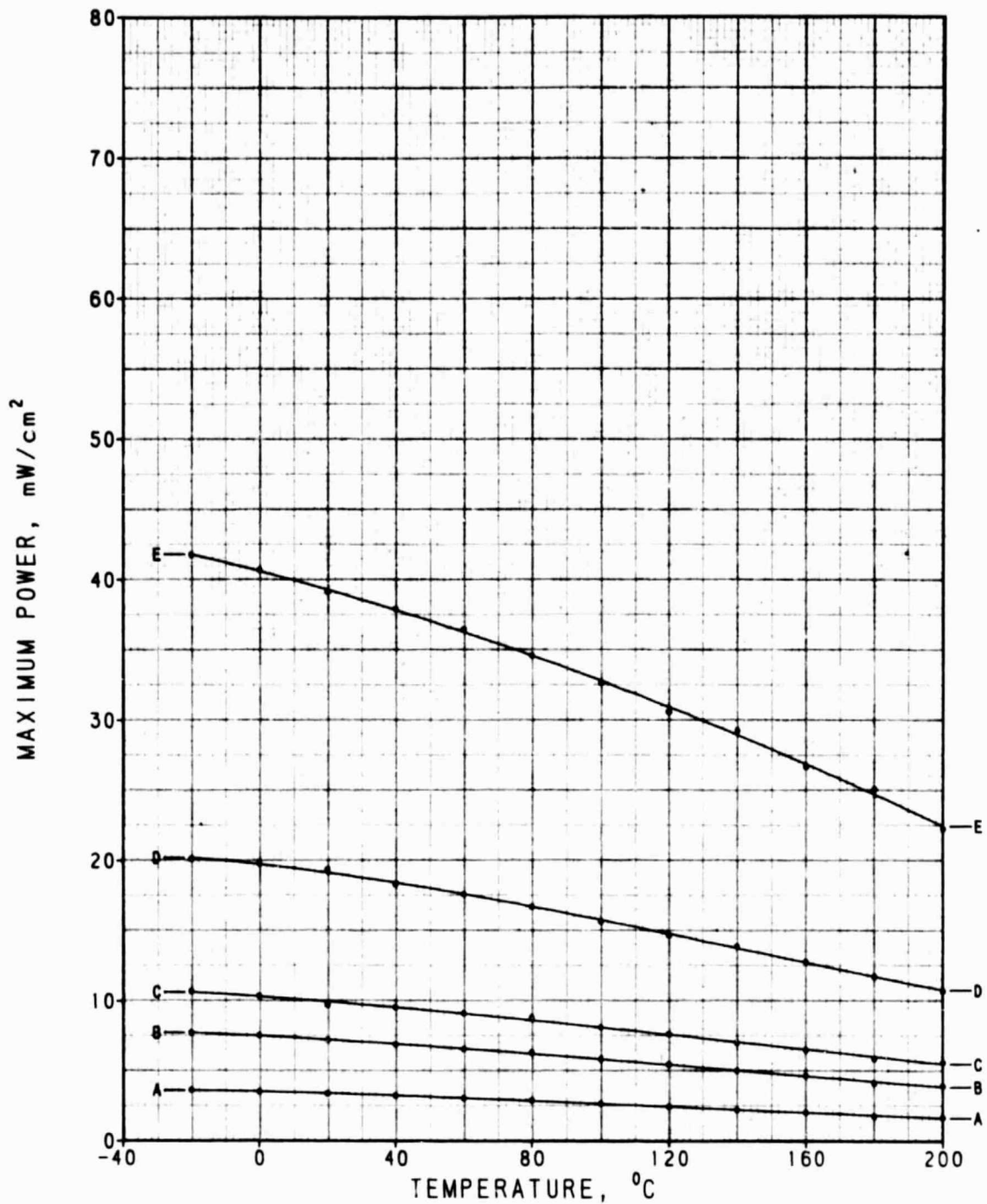


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 58. Average V_{mp} as a Function of Temperature
After 10^{16} electrons/cm²

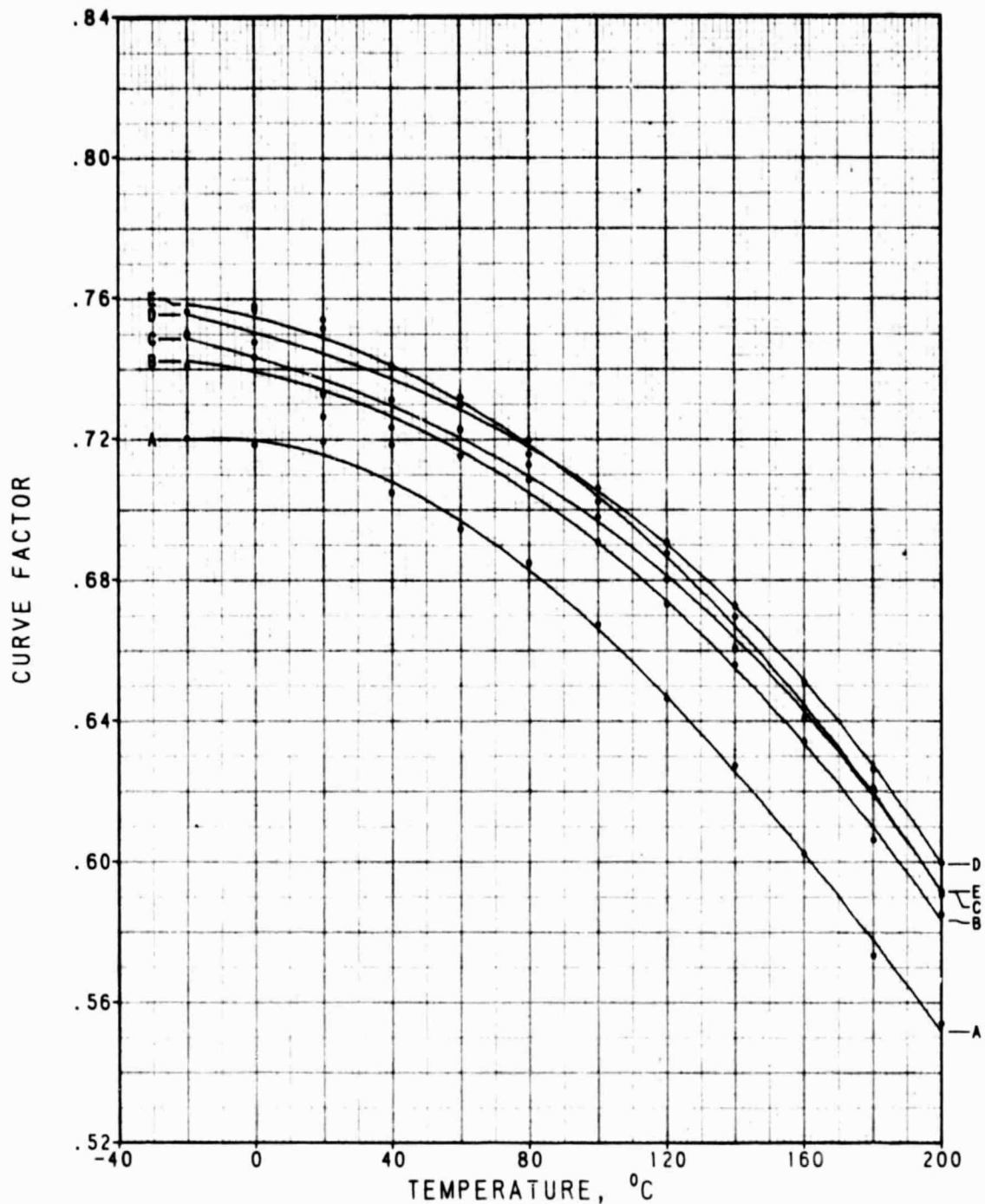
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ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 59. Average P_{\max}/cm^2 as a Function of Temperature
After 10^{16} electrons/cm²

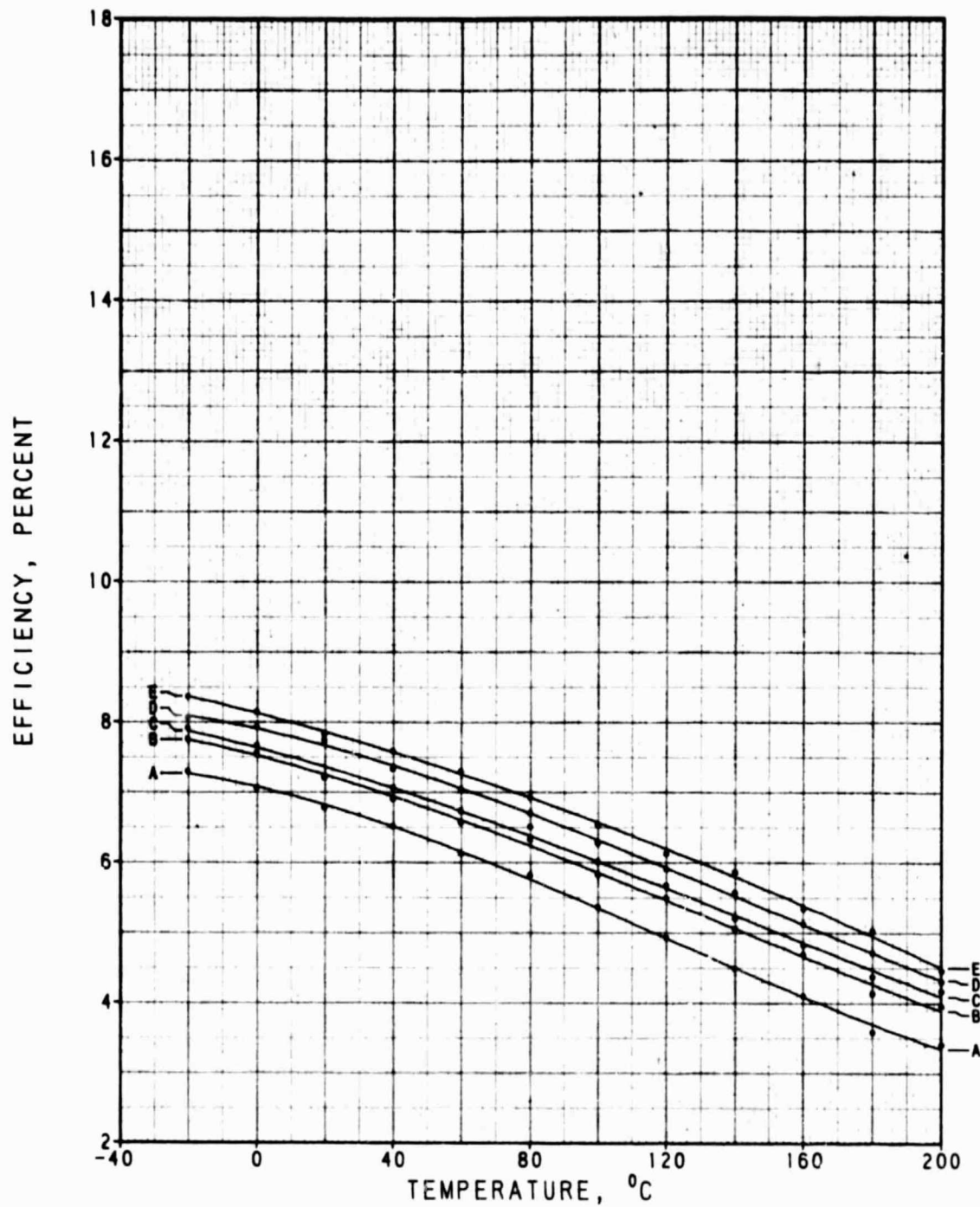


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 60. Average Curve Factor as a Function of Temperature
After 10^{16} electrons/cm²

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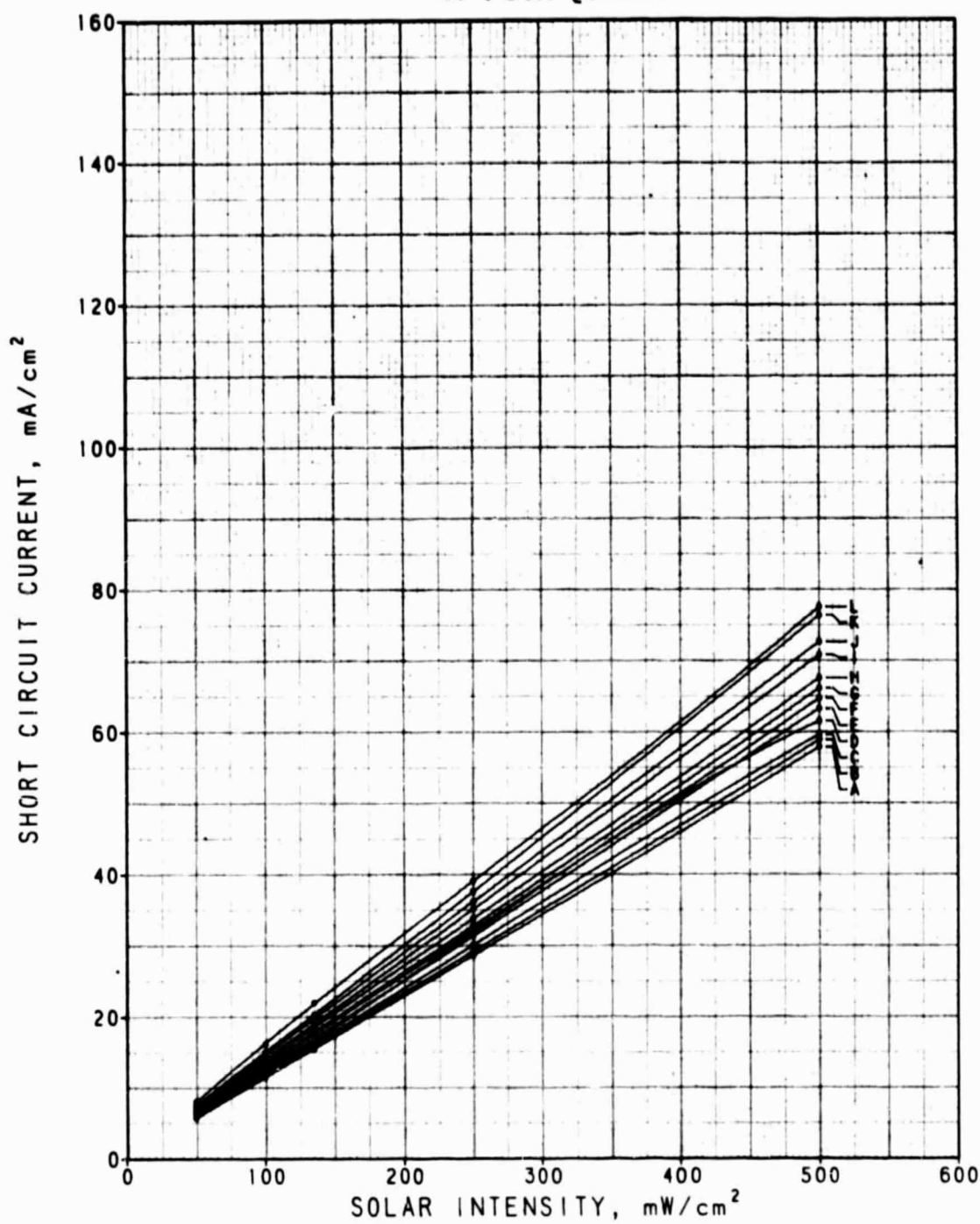


ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
T₀₂₀₅ A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 61. Average AMO Efficiency as a Function of Temperature
After 10^{16} electrons/cm²

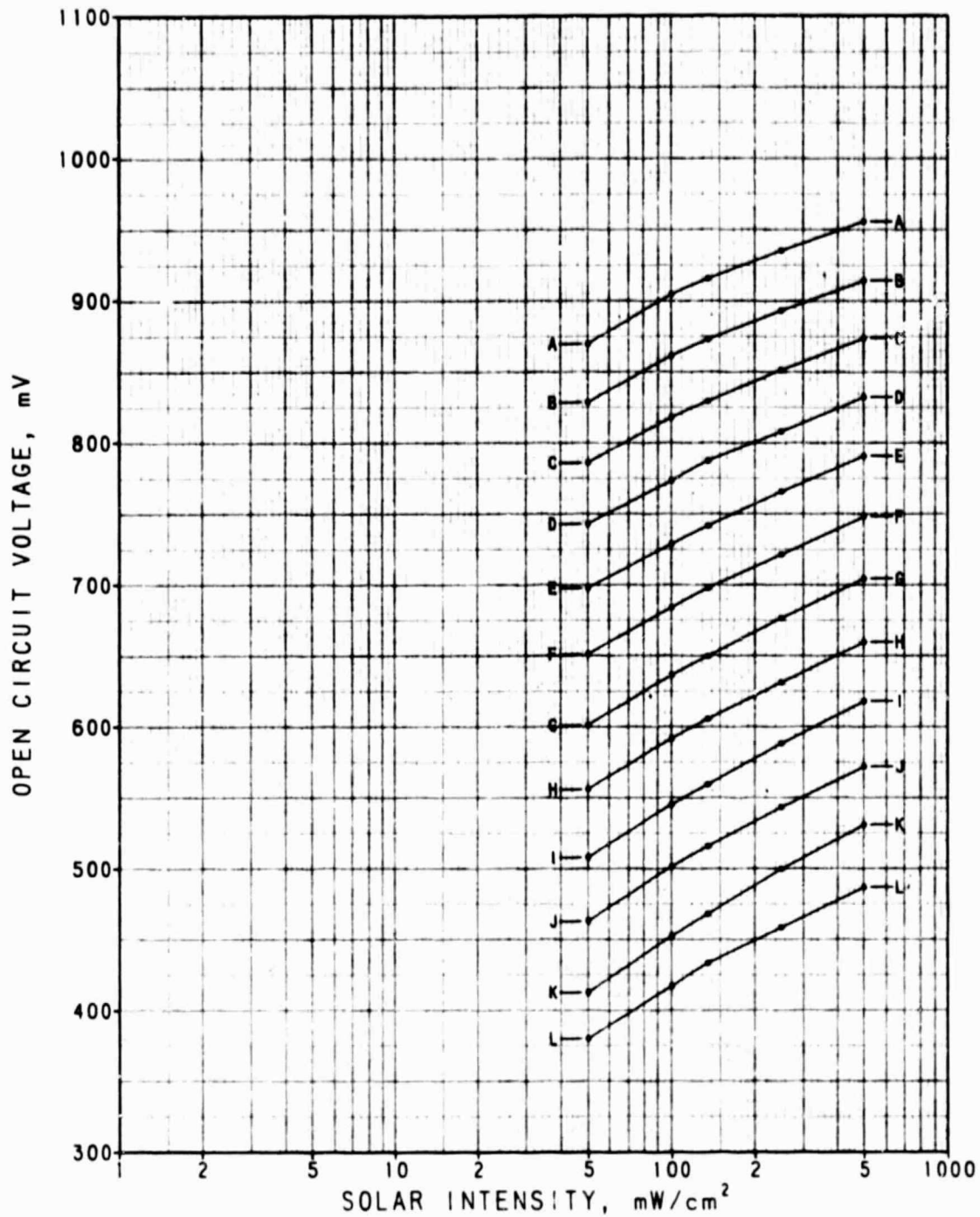
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ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER $1.E16$ e/cm² TM-58

Figure 62. Average I_{sc}/cm^2 as a Function of Intensity
After 10^{16} electrons/cm²

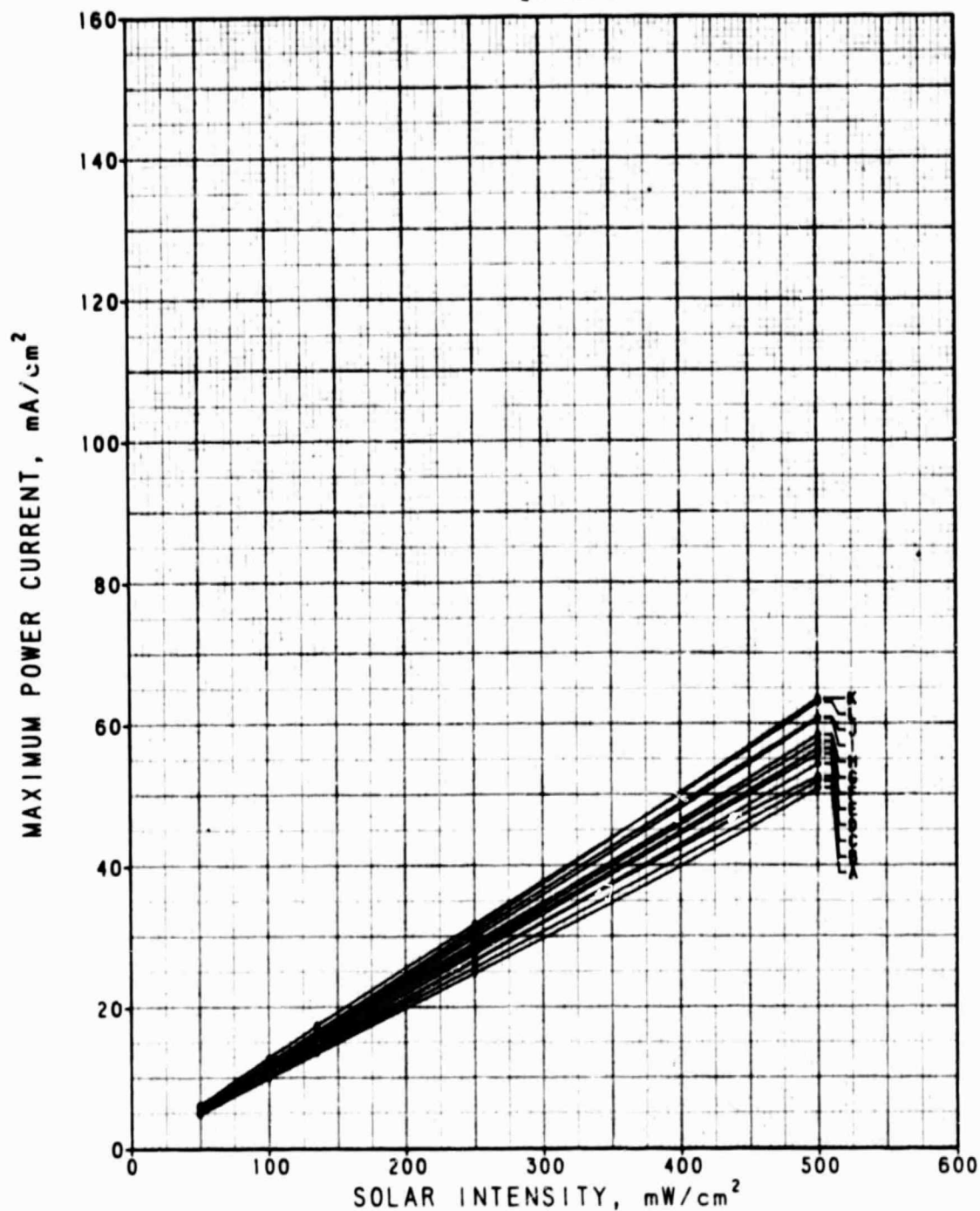


ID	$^{\circ}\text{C}$	ID	$^{\circ}\text{C}$
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER $1.E16 \text{ e}/\text{cm}^2$ TM-58

Figure 63. Average V_{oc} as a Function of Intensity
After 10^{16} electrons/ cm^2

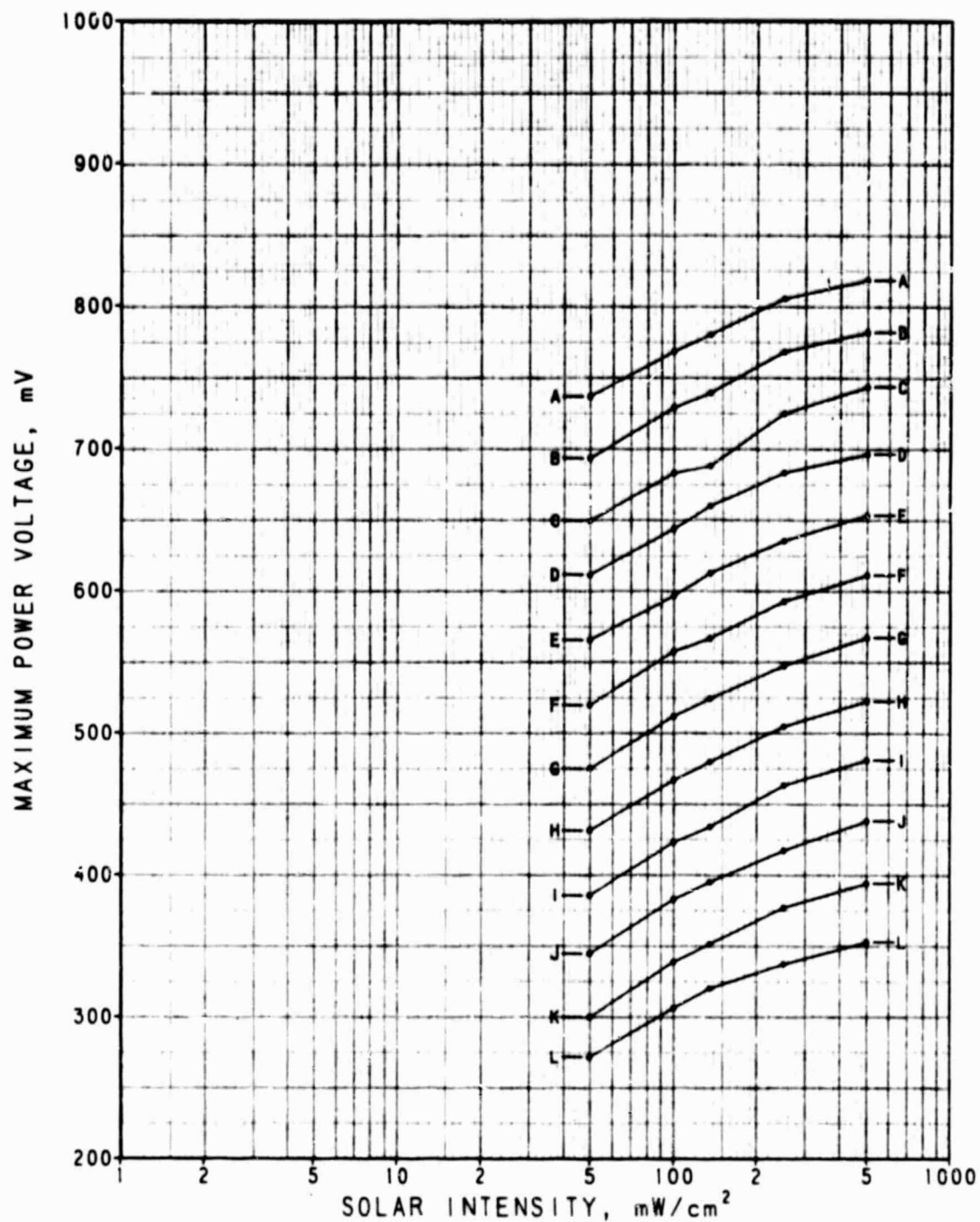
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ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 64. Average I_{mp}/cm^2 as a Function of Intensity
After 10^{16} electrons/cm²

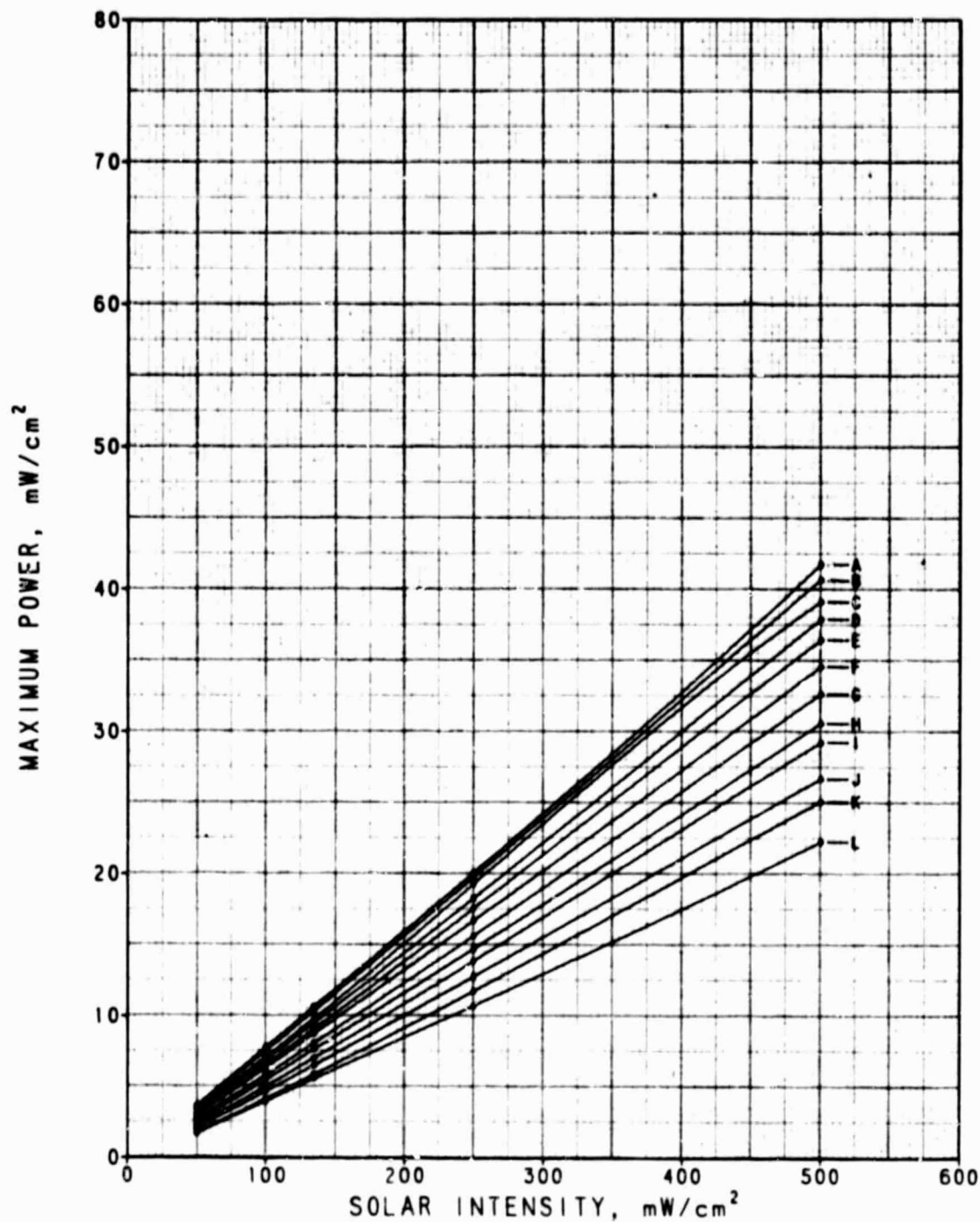


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0.05 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 65. Average V_{mp} as a Function of Intensity
After 10^{16} electrons/cm²

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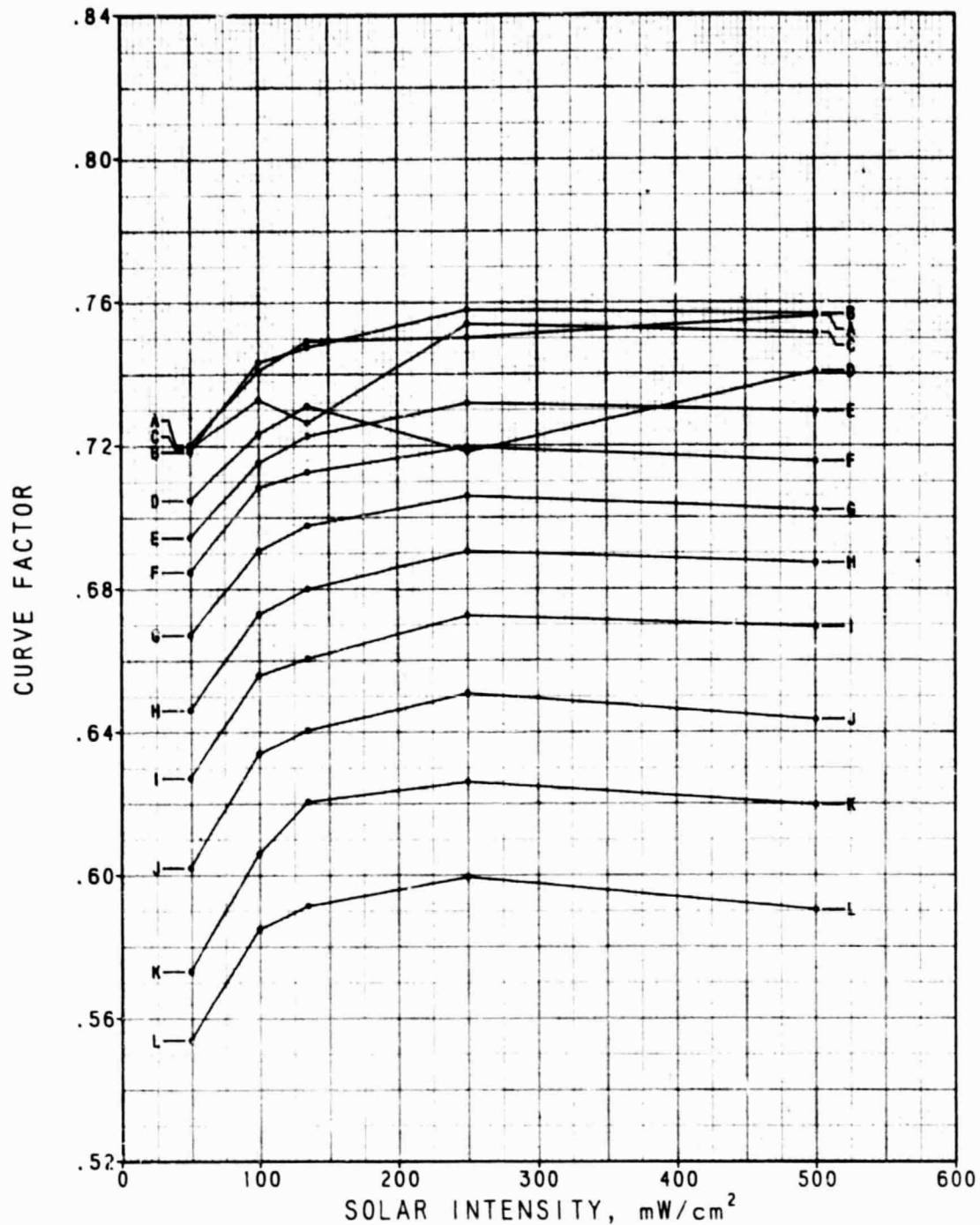


ID	°C	ID	°C
A	-20.0	I	140.0
B	.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Te205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm²2 TM-58

Figure 66. Average P_{\max}/cm^2 as a Function of Intensity
After 10^{16} electrons/ cm^2

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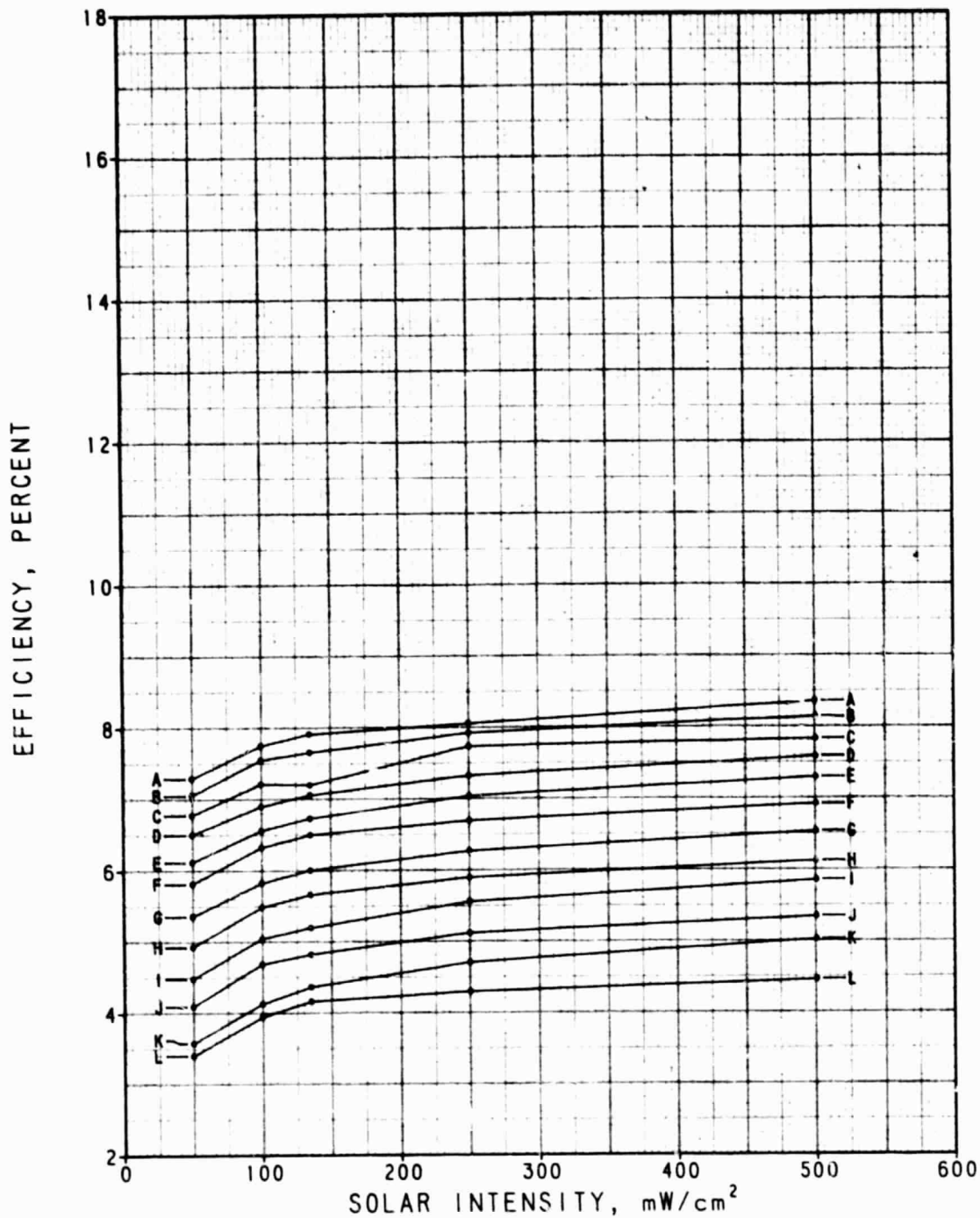


ID	°C	ID	°C
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B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Tc205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm²2 TM-58

Figure 67. Average Curve Factor as a Function of Intensity
After 10^{16} electrons/cm²

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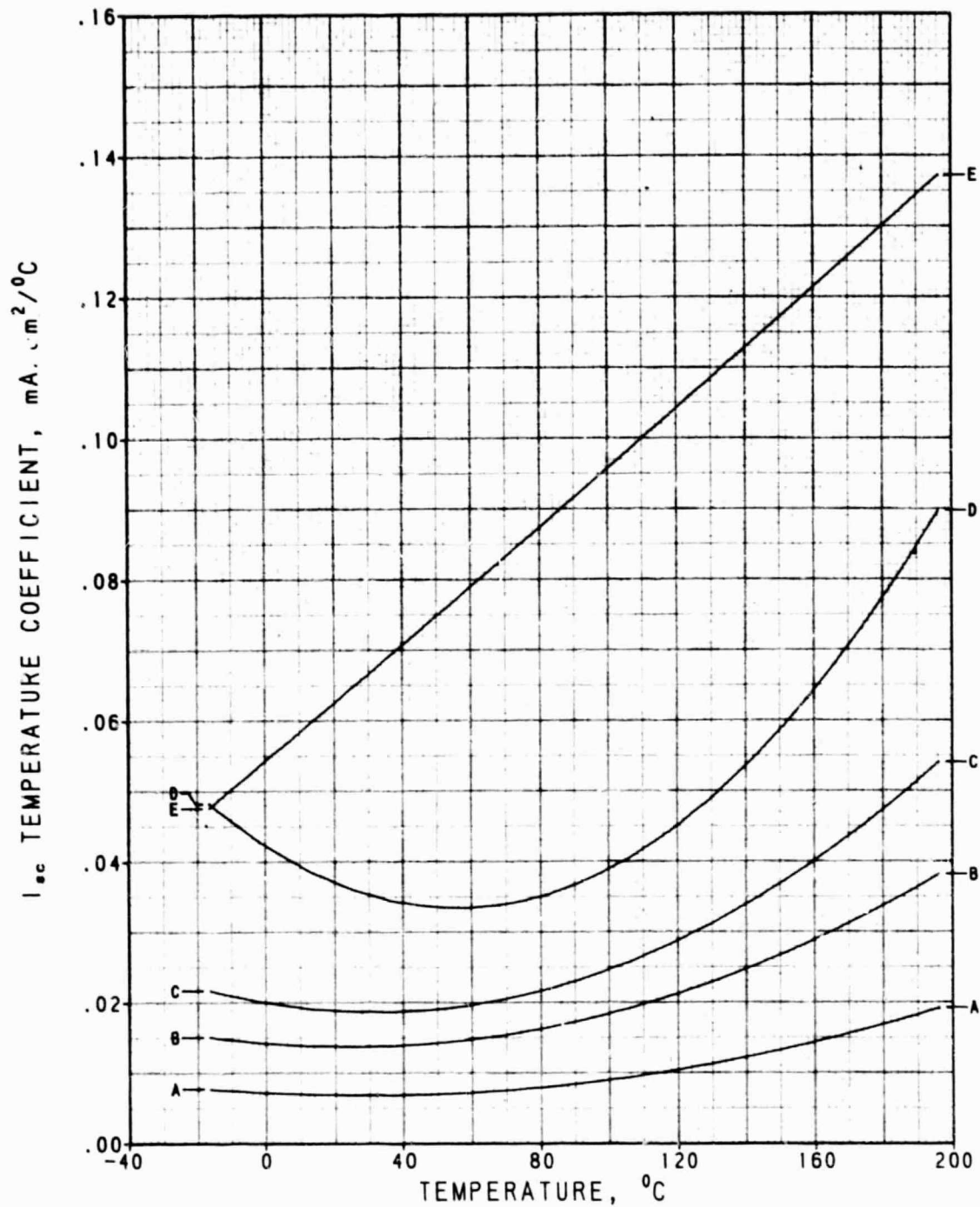


ID	°C	ID	°C
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B	0.0	J	160.0
C	20.0	K	180.0
D	40.0	L	200.0
E	60.0		
F	80.0		
G	100.0		
H	120.0		

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 68. Average AMO Efficiency as a Function of Intensity
After 10^{16} electrons/cm²

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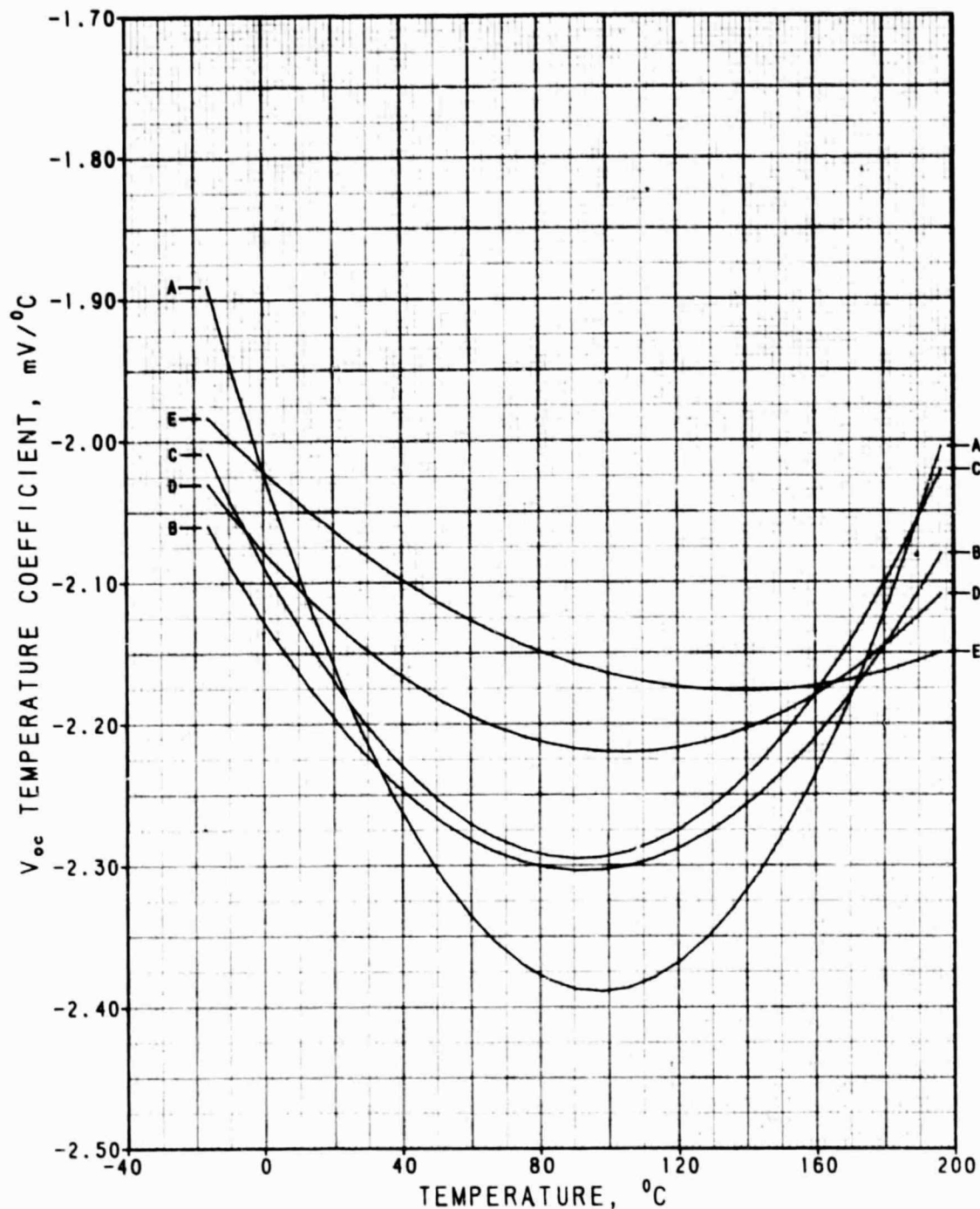


ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 69. I_{sc} Temperature Coefficient
After 10^{16} electrons/cm²

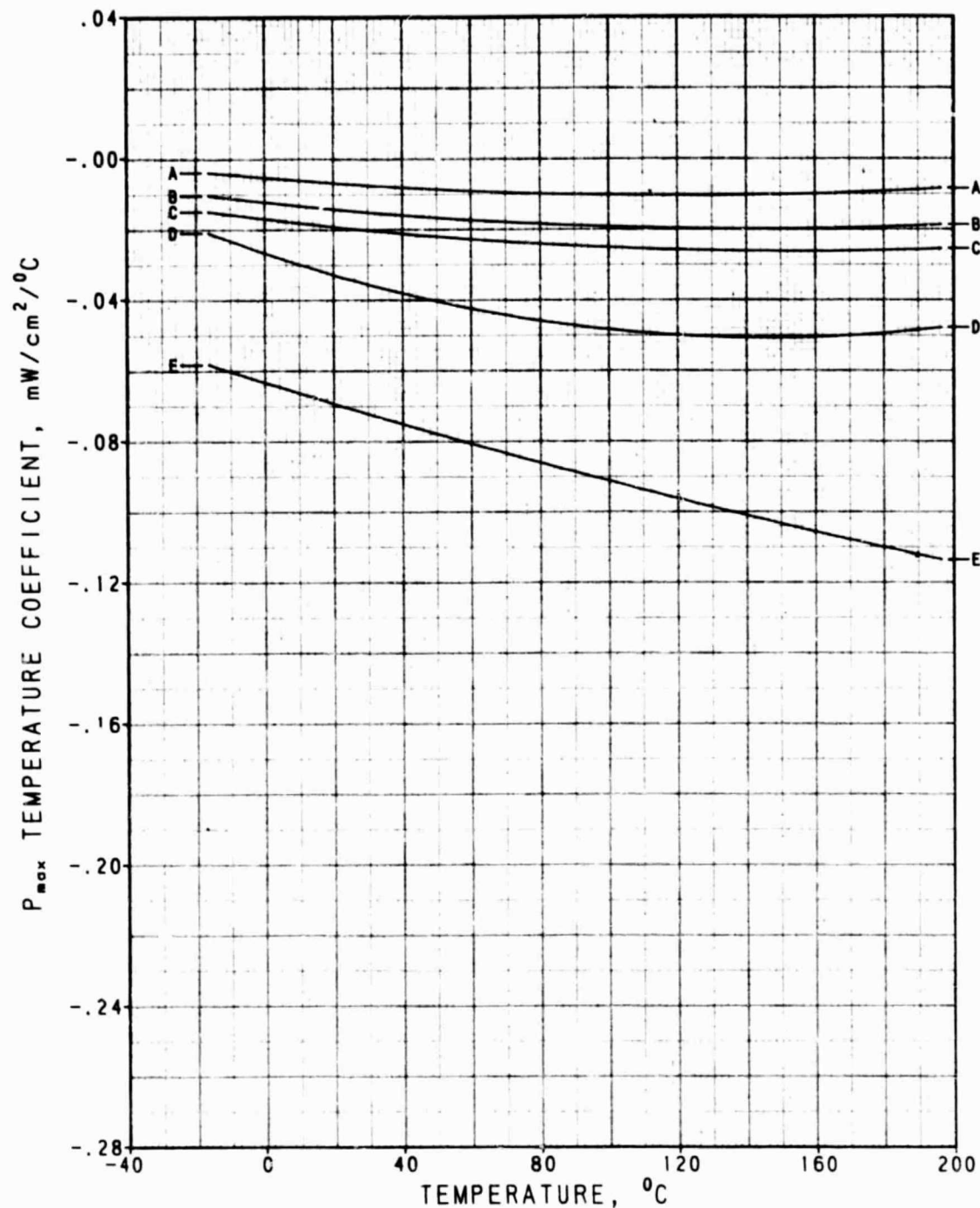
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ID mW/cm²
A 50.0
B 100.0
C 135.3
D 250.0
E 500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 70. V_{oc} Temperature Coefficient
After 10^{16} electrons/cm²

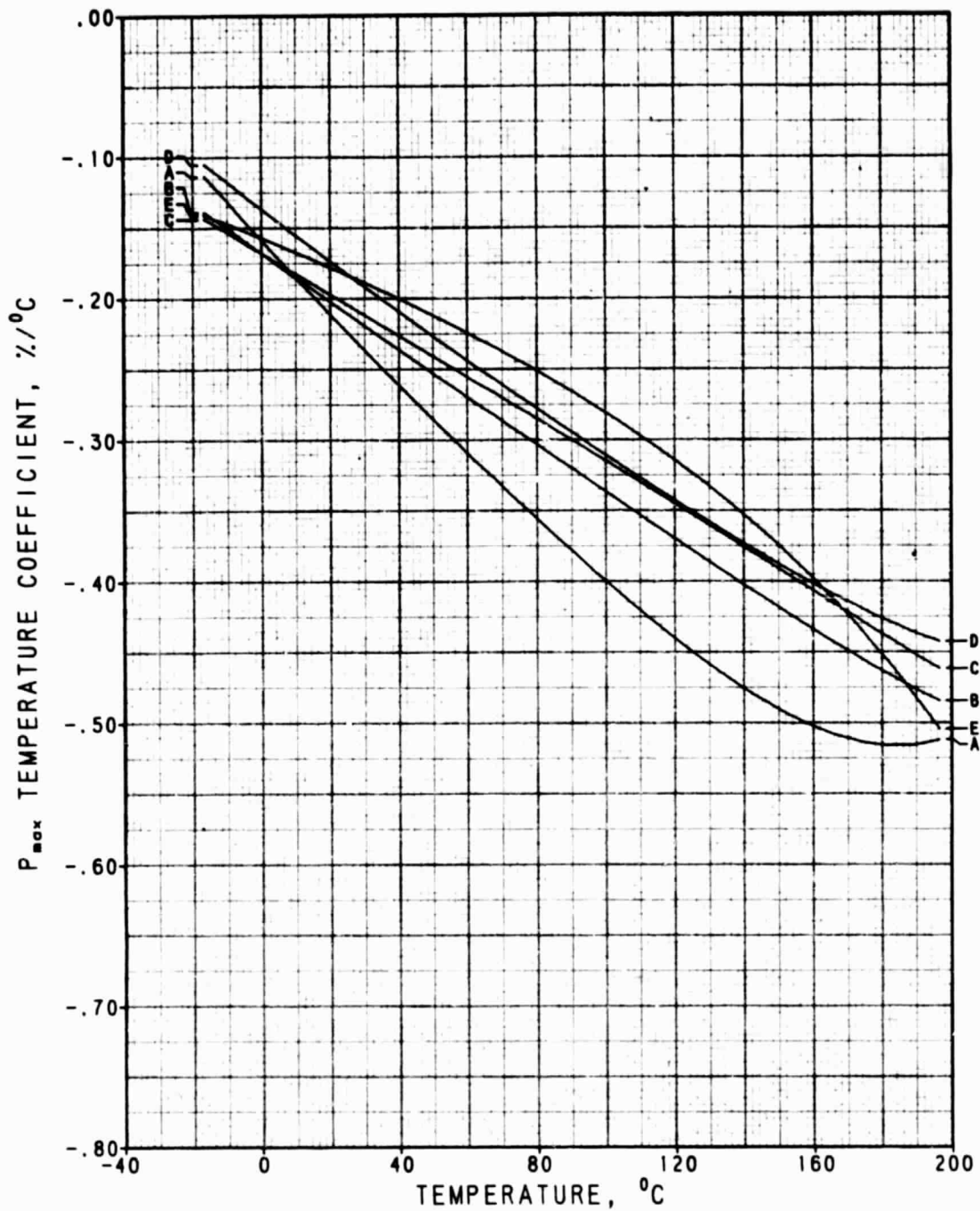


ID	mW/cm^2
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
To205 A-R. 7940 COVER .03 CM
AFTER $1.E16 \text{ e}/\text{cm}^2$ TM-58

Figure 71. Absolute P_{max} Temperature Coefficient
After $10^{16} \text{ electrons}/\text{cm}^2$

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ID	mW/cm ²
A	50.0
B	100.0
C	135.3
D	250.0
E	500.0

HUGHES LPE GaAs CELLS (9/79)
P/N JUNCTION .LE. 0.5 MICRONS
WINDOW .LE. 0.5 MICRONS
2X2X.0305 CM (SAMPLE SIZE 7)
CONTACTS FRONT: (Ni Ge Au)/Ag
REAR: Au-Zn/Ag
Ta205 A-R. 7940 COVER .03 CM
AFTER 1.E16 e/cm² TM-58

Figure 72. Percent P_{max} Temperature Coefficient
After 10^{16} electrons/cm²

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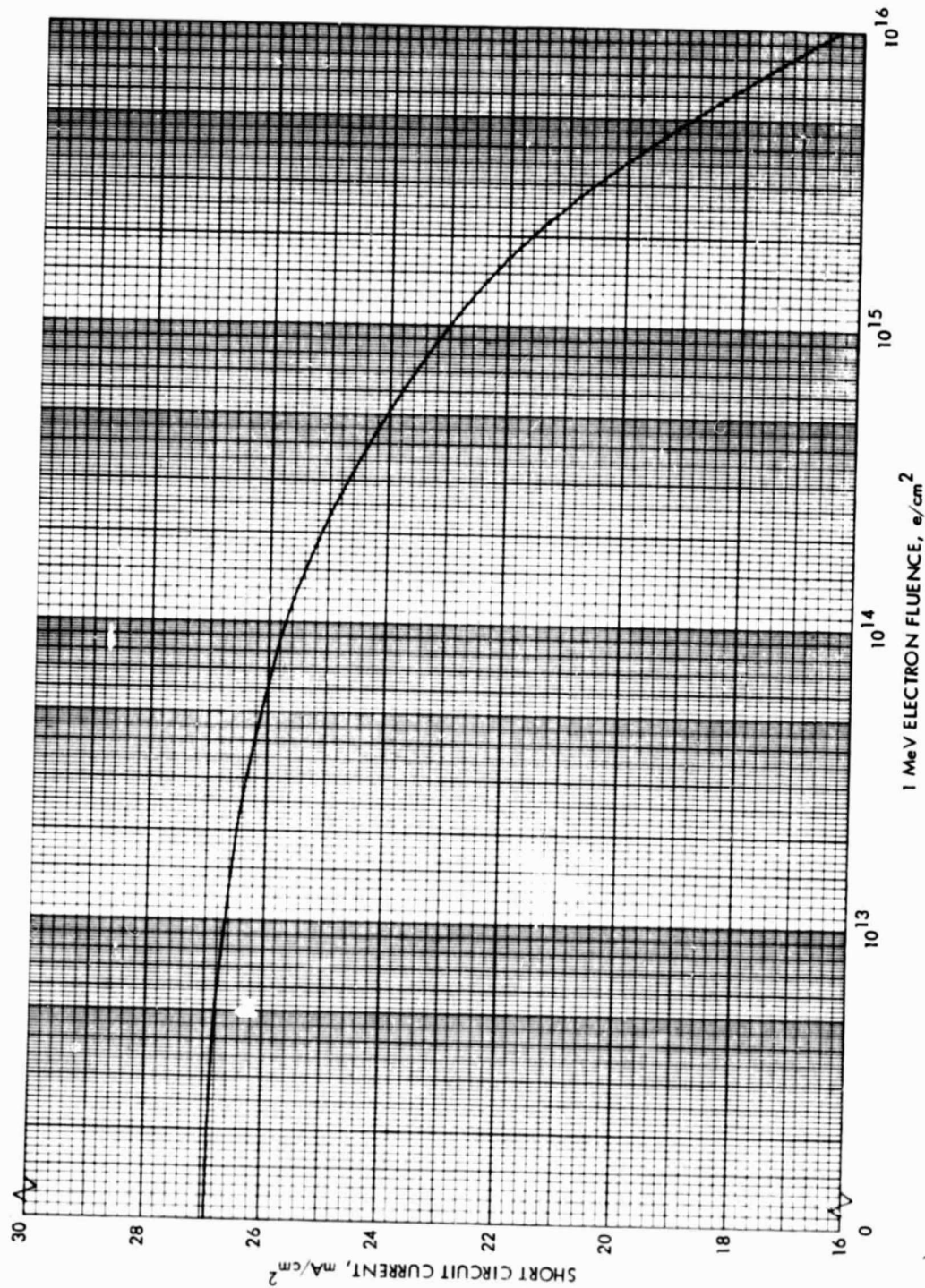


Figure 73. Short Circuit Current Density vs 1 MeV Electron Fluence at 135.3 mW/cm² AMO Illumination, 28°C

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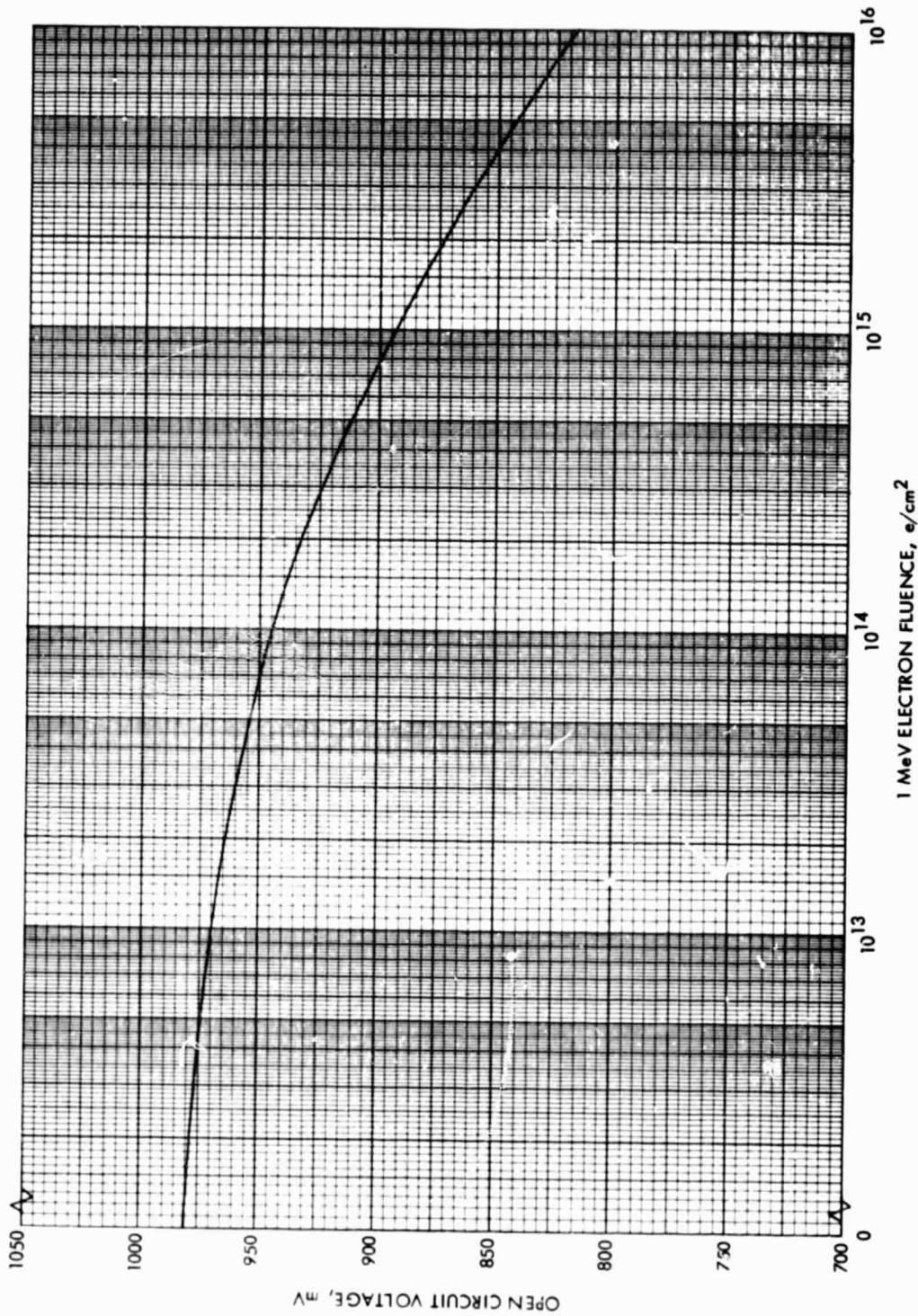


Figure 74. Open Circuit Voltage vs 1 MeV Electron Fluence
at 135.3 mW/cm² AND Illumination, 28°C

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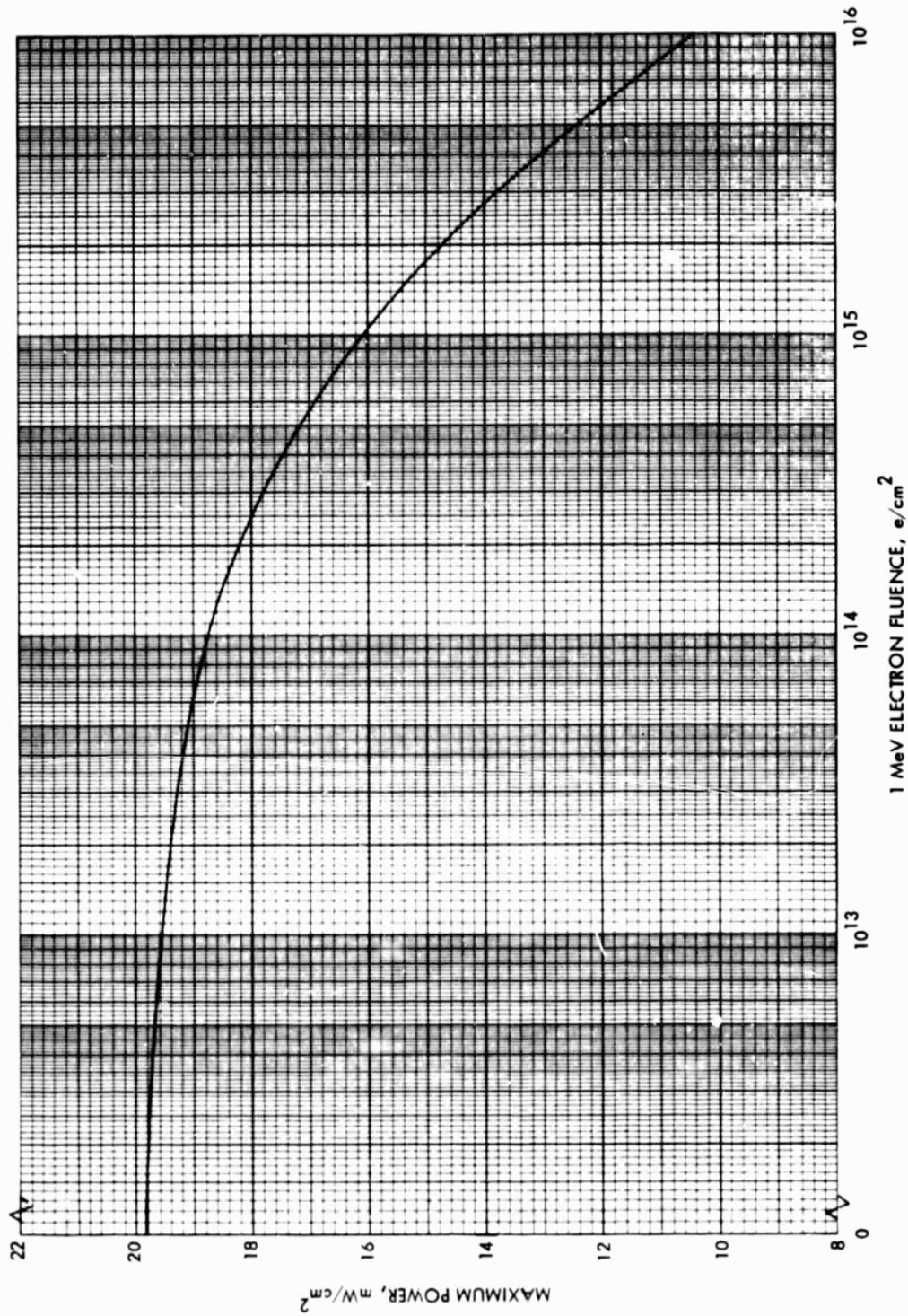


Figure 75. Maximum Power Density vs 1 MeV Electron Fluence
at 135.3 mW/cm² AMO Illumination, 28°C

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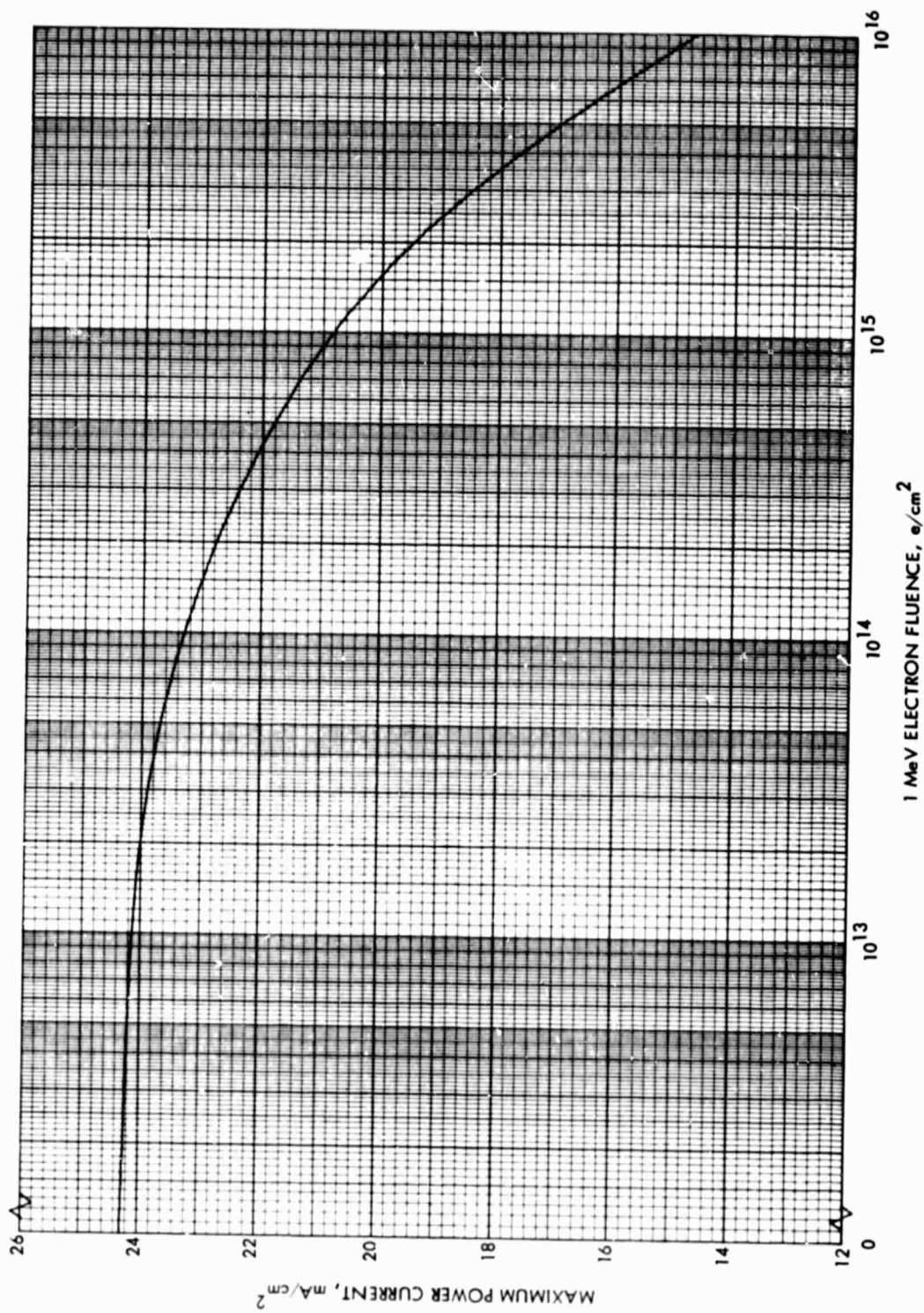


Figure 76. Maximum Power Current Density vs 1 MeV Electron Fluence
at 135.3 mW/cm² AMO Illumination, 28°C

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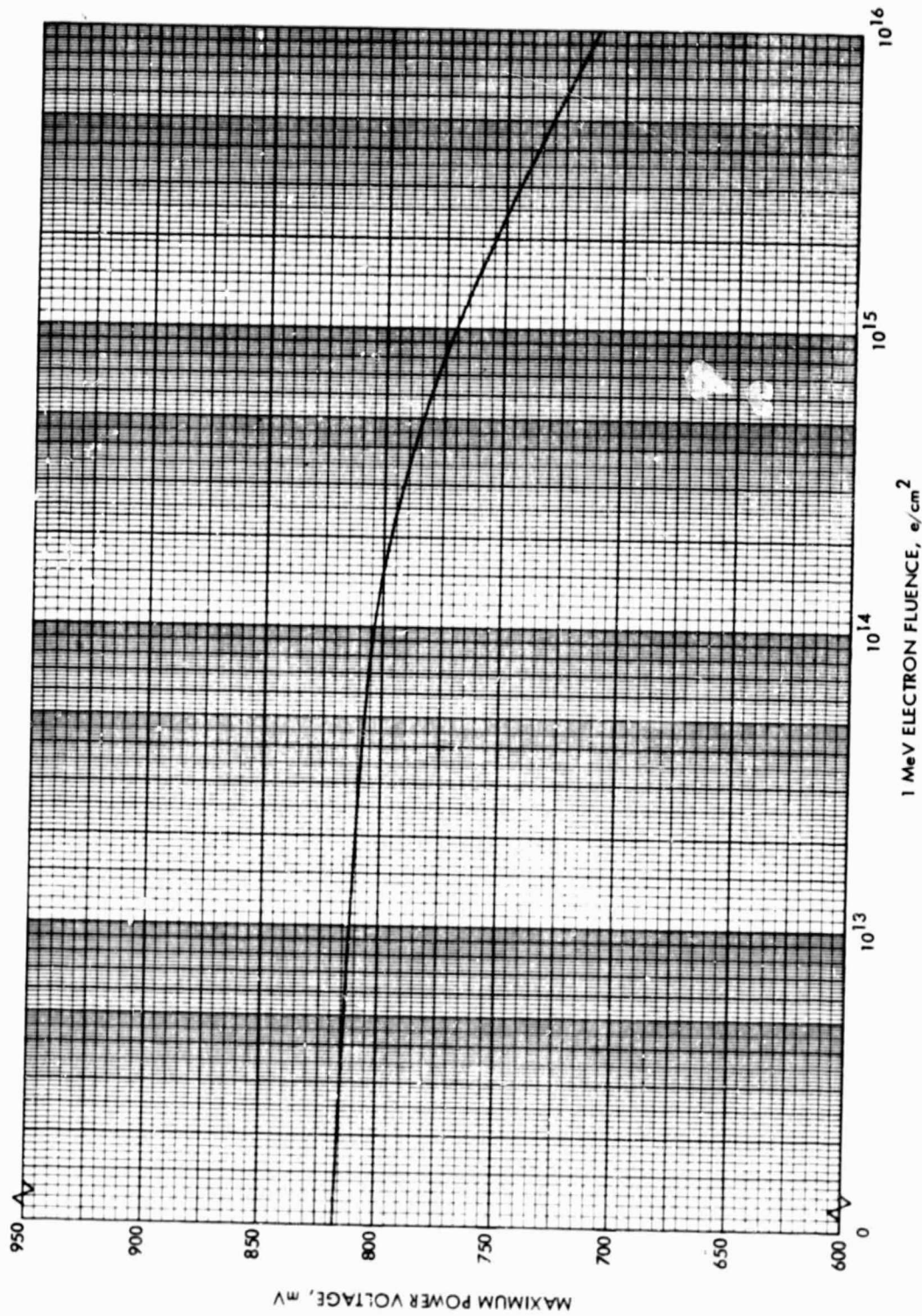


Figure 77. Voltage at Maximum Power vs 1 MeV Electron Fluence at 135.3 mW/cm² AND Illumination, 28°C

Table 1. Average Short Circuit Current (mA/cm²)
Pre-Irradiation

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM PRE-IRRADIATION TM-					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	10.10 (.17)	19.52 (.45)	26.38 (.55)	49.64 (1.10)	100.77 (2.09)
.00	10.06 (.18)	19.51 (.45)	26.51 (.55)	49.84 (1.09)	101.15 (2.23)
20.00	10.21 (.19)	19.73 (.45)	26.80 (.55)	50.53 (1.05)	102.03 (2.04)
40.00	10.36 (.20)	20.29 (.47)	27.32 (.64)	51.18 (1.14)	103.27 (2.12)
60.00	10.47 (.23)	20.60 (.47)	27.85 (.62)	52.08 (1.07)	104.97 (2.29)
80.00	10.60 (.19)	20.89 (.46)	28.15 (.60)	52.75 (.96)	106.10 (2.16)
100.00	10.74 (.18)	21.09 (.49)	28.55 (.57)	53.07 (1.07)	107.29 (2.32)
120.00	10.82 (.20)	21.33 (.50)	28.95 (.61)	53.52 (1.02)	108.47 (2.51)
140.00	10.92 (.21)	21.52 (.48)	29.14 (.60)	54.22 (1.17)	109.21 (2.22)
160.00	11.06 (.22)	21.75 (.49)	29.33 (.59)	54.93 (1.10)	110.07 (2.30)
180.00	11.13 (.24)	21.92 (.52)	29.70 (.62)	55.06 (1.13)	111.15 (2.81)
200.00	11.18 (.22)	22.04 (.54)	29.87 (.68)	55.57 (1.07)	111.86 (2.6~)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 2. Average Open Circuit Voltage (mV)
Pre-Irradiation

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM PRE-IRRADIATION TM-					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	1027.93 (16.63)	1062.00 (8.89)	1074.29 (7.13)	1096.23 (4.00)	1115.23 (3.33)
.00	987.84 (12.68)	1022.54 (7.41)	1034.90 (6.28)	1058.80 (4.42)	1080.80 (3.49)
20.00	948.37 (10.30)	982.24 (6.52)	955.23 (5.78)	1019.53 (3.88)	1043.07 (2.76)
40.00	907.19 (8.86)	942.44 (6.44)	955.51 (5.16)	979.61 (3.61)	1002.97 (5.68)
60.00	864.66 (7.72)	900.99 (5.55)	914.74 (5.23)	940.31 (3.91)	965.79 (4.78)
80.00	822.53 (7.06)	859.76 (5.09)	873.61 (4.91)	899.07 (4.35)	926.53 (4.14)
100.00	778.94 (7.04)	817.87 (4.95)	832.40 (4.71)	858.86 (4.38)	885.73 (4.95)
120.00	733.90 (7.08)	775.51 (5.32)	790.50 (5.21)	818.11 (4.76)	846.37 (4.91)
140.00	689.19 (7.19)	732.04 (5.53)	747.71 (5.12)	777.40 (5.02)	806.29 (5.26)
160.00	643.27 (7.21)	688.17 (5.67)	704.26 (5.71)	735.93 (5.11)	765.84 (4.51)
180.00	595.81 (7.32)	642.90 (6.12)	661.03 (5.63)	693.11 (5.23)	724.37 (5.17)
200.00	548.26 (7.75)	597.07 (6.25)	616.49 (6.11)	650.36 (5.79)	684.33 (5.23)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 3. Average Maximum Power Current (mA/cm²)
Pre-Irradiation

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM PRE-IRRADIATION TM-					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	9.17 (.23)	17.82 (.56)	24.00 (.60)	45.18 (.99)	91.96 (2.29)
.00	9.12 (.24)	17.72 (.50)	24.17 (.57)	45.21 (1.24)	92.00 (2.21)
20.00	9.19 (.24)	17.87 (.43)	24.34 (.67)	45.79 (1.01)	92.29 (1.85)
40.00	9.22 (.21)	18.27 (.51)	24.57 (.73)	45.86 (1.18)	93.46 (1.69)
60.00	9.28 (.26)	18.27 (.41)	24.85 (.69)	46.64 (.72)	94.36 (2.07)
80.00	9.27 (.23)	18.49 (.51)	24.98 (.56)	46.57 (1.12)	94.43 (1.62)
100.00	9.28 (.21)	18.40 (.49)	25.01 (.57)	46.46 (.73)	94.89 (1.74)
120.00	9.20 (.15)	18.39 (.48)	25.06 (.54)	46.39 (.97)	95.32 (2.19)
140.00	9.18 (.20)	18.23 (.47)	24.98 (.59)	46.32 (.90)	94.75 (2.26)
160.00	9.04 (.20)	18.14 (.45)	24.75 (.61)	46.43 (.93)	94.82 (2.02)
180.00	8.86 (.21)	17.86 (.48)	24.49 (.51)	46.46 (1.02)	94.50 (1.98)
200.00	8.67 (.19)	17.50 (.56)	24.22 (.70)	46.04 (1.01)	94.11 (1.67)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 4. Average Maximum Power Voltage (mV)
Pre-Irradiation

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM PRE-IRRADIATION TM-					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	851.86 (21.56)	881.29 (20.32)	901.29 (17.83)	930.86 (12.50)	944.71 (16.52)
.00	811.14 (16.81)	845.00 (13.82)	865.29 (14.48)	895.43 (13.20)	914.86 (14.70)
20.00	771.86 (14.55)	806.00 (10.31)	824.57 (13.26)	851.57 (9.14)	876.57 (12.39)
40.00	731.57 (9.16)	768.71 (12.97)	788.29 (9.59)	818.57 (8.70)	838.29 (9.16)
60.00	687.71 (9.81)	732.14 (9.97)	749.86 (9.63)	779.29 (3.25)	809.71 (8.20)
80.00	646.43 (9.73)	689.57 (10.03)	709.14 (9.97)	738.43 (7.79)	769.71 (8.20)
100.00	601.00 (6.68)	649.57 (8.96)	670.14 (8.86)	699.43 (8.92)	728.00 (6.93)
120.00	558.71 (11.37)	607.43 (8.02)	630.29 (9.71)	659.71 (4.72)	691.43 (5.62)
140.00	517.57 (8.04)	568.00 (8.23)	586.43 (6.27)	619.57 (4.58)	651.57 (8.72)
160.00	479.14 (8.30)	528.00 (6.73)	543.71 (8.42)	578.86 (7.49)	607.57 (9.03)
180.00	436.71 (7.70)	489.29 (5.99)	509.71 (6.78)	540.43 (4.43)	565.29 (5.28)
200.00	394.29 (6.80)	447.14 (7.71)	466.43 (5.03)	499.71 (6.26)	529.29 (4.03)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

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Table 5. Average Maximum Power (mW/cm²)
Pre-Irradiation

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM PRE-IRRADIATION TM-					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	7.82 (.32)	15.71 (.55)	21.64 (.73)	42.05 (.82)	86.86 (1.41)
.00	7.40 (.27)	14.97 (.48)	20.92 (.60)	40.48 (1.02)	84.15 (1.82)
20.00	7.10 (.24)	14.41 (.46)	20.07 (.58)	38.99 (.73)	80.88 (1.37)
40.00	6.75 (.19)	14.04 (.45)	19.36 (.56)	37.53 (.78)	78.35 (1.63)
60.00	6.38 (.20)	13.38 (.37)	18.63 (.54)	36.35 (.54)	76.40 (1.79)
80.00	5.99 (.19)	12.75 (.35)	17.71 (.39)	34.38 (.65)	72.68 (1.20)
100.00	5.58 (.15)	11.95 (.31)	16.76 (.36)	32.50 (.48)	69.08 (1.07)
120.00	5.14 (.14)	11.17 (.31)	15.79 (.31)	30.61 (.64)	65.90 (1.31)
140.00	4.75 (.14)	10.35 (.31)	14.65 (.33)	28.70 (.60)	61.72 (.95)
160.00	4.33 (.15)	9.58 (.27)	13.45 (.39)	26.87 (.61)	57.60 (.73)
180.00	3.87 (.12)	8.74 (.25)	12.48 (.30)	25.11 (.47)	53.41 (.79)
200.00	3.42 (.12)	7.83 (.30)	11.30 (.32)	23.00 (.46)	49.81 (.83)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 6. Average Curve Factor
Pre-Irradiation

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM PRE-IRRADIATION TM-					
CELL TEMP. (DEG. C)	50.00	100.00	135.30	250.00	500.00
-20.00	.7526 (.0218)	.7576 (.0190)	.7635 (.0218)	.7728 (.0131)	.7730 (.0119)
.00	.7444 (.0161)	.7505 (.0165)	.7622 (.0156)	.7671 (.0096)	.7699 (.0121)
20.00	.7330 (.0150)	.7432 (.0139)	.7524 (.0147)	.7568 (.0066)	.7601 (.0110)
40.00	.7180 (.0119)	.7343 (.0128)	.7417 (.0094)	.7486 (.0083)	.7565 (.0100)
60.00	.7047 (.0103)	.7208 (.0111)	.7313 (.0080)	.7423 (.0124)	.7537 (.0143)
80.00	.6871 (.0102)	.7100 (.0100)	.7203 (.0076)	.7251 (.0077)	.7395 (.0107)
100.00	.6668 (.0088)	.6926 (.0079)	.7051 (.0081)	.7130 (.0092)	.7271 (.0105)
120.00	.6477 (.0091)	.6750 (.0071)	.6903 (.0075)	.6990 (.0096)	.7180 (.0127)
140.00	.6314 (.0087)	.6573 (.0089)	.6724 (.0074)	.6809 (.0065)	.7011 (.0108)
160.00	.6085 (.0087)	.6399 (.0077)	.6513 (.0102)	.6648 (.0107)	.6835 (.0120)
180.00	.5836 (.0087)	.6200 (.0079)	.6358 (.0099)	.6579 (.0074)	.6636 (.0118)
200.00	.5577 (.0097)	.5948 (.0120)	.6136 (.0091)	.6365 (.0059)	.6508 (.0116)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 7. Average AMO Efficiency (Percent)
Pre-Irradiation

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM PRE-IRRADIATION TM-					
CELL TEMP. (DEG. C)	50.00	100.00	135.30	250.00	500.00
-20.00	15.63 (.64)	15.71 (.55)	15.99 (.54)	16.82 (.53)	17.37 (.28)
.00	14.80 (.54)	14.97 (.48)	15.46 (.44)	16.19 (.41)	16.83 (.36)
20.00	14.19 (.47)	14.41 (.46)	14.83 (.43)	15.59 (.29)	16.18 (.27)
40.00	13.50 (.39)	14.04 (.45)	14.31 (.42)	15.01 (.31)	15.67 (.33)
60.00	12.77 (.40)	13.38 (.37)	13.77 (.40)	14.54 (.21)	15.28 (.36)
80.00	11.99 (.38)	12.75 (.35)	13.09 (.29)	13.75 (.26)	14.54 (.24)
100.00	11.15 (.30)	11.95 (.31)	12.39 (.27)	13.00 (.19)	13.82 (.21)
120.00	10.28 (.29)	11.17 (.31)	11.67 (.23)	12.24 (.26)	13.18 (.26)
140.00	9.51 (.28)	10.35 (.31)	10.83 (.24)	11.48 (.24)	12.34 (.19)
160.00	8.66 (.30)	9.58 (.27)	9.94 (.29)	10.75 (.24)	11.52 (.15)
180.00	7.74 (.24)	8.74 (.25)	9.23 (.22)	10.04 (.19)	10.68 (.16)
200.00	6.84 (.24)	7.83 (.30)	8.35 (.24)	9.20 (.18)	9.96 (.17)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 8. Average Short Circuit Current (mA/cm²)
After 10¹⁴ electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E14 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	9.25 (.18)	18.40 (.39)	24.93 (.54)	45.91 (1.03)	92.49 (2.11)
.00	9.29 (.20)	18.56 (.46)	25.08 (.55)	46.36 (1.08)	93.38 (2.04)
20.00	9.32 (.21)	18.61 (.45)	25.24 (.61)	46.89 (1.18)	93.65 (2.18)
40.00	9.49 (.21)	18.89 (.47)	25.61 (.61)	47.26 (1.16)	95.06 (2.18)
60.00	9.57 (.19)	19.08 (.43)	25.86 (.56)	47.79 (1.08)	95.84 (2.18)
80.00	9.91 (.21)	19.65 (.50)	26.59 (.61)	48.68 (1.26)	96.89 (2.35)
100.00	9.95 (.19)	19.93 (.47)	27.00 (.55)	49.95 (1.24)	99.96 (2.55)
120.00	10.12 (.20)	20.25 (.52)	27.47 (.61)	50.50 (1.16)	101.71 (2.39)
140.00	10.09 (.21)	20.15 (.49)	27.29 (.63)	50.52 (1.16)	101.30 (2.34)
160.00	10.37 (.24)	20.71 (.57)	28.23 (.68)	51.21 (1.40)	102.12 (2.65)
180.00	10.43 (.21)	20.83 (.56)	28.25 (.69)	52.33 (1.23)	105.28 (2.93)
200.00	10.82 (.27)	21.53 (.52)	29.06 (.65)	53.52 (1.45)	106.94 (3.11)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 9. Average Open Circuit Voltage (mV)
After 10^{14} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER $1.E14$ E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	993.27 (11.45)	1024.26 (6.38)	1035.71 (4.96)	1054.96 (3.18)	1077.81 (2.77)
.00	954.97 (8.90)	983.63 (5.52)	995.44 (4.06)	1016.80 (3.11)	1038.00 (2.37)
20.00	913.33 (7.60)	944.41 (4.69)	955.71 (4.24)	977.84 (3.11)	999.94 (2.44)
40.00	871.36 (6.68)	903.03 (3.94)	915.29 (3.53)	937.76 (2.77)	960.33 (2.77)
60.00	828.64 (5.97)	861.91 (3.68)	874.34 (3.49)	897.44 (2.92)	920.91 (2.83)
80.00	786.99 (5.43)	818.69 (3.42)	831.60 (3.06)	856.09 (3.69)	879.84 (2.54)
100.00	741.14 (4.67)	776.71 (3.62)	790.74 (3.21)	814.67 (3.10)	840.76 (3.21)
120.00	696.66 (4.48)	732.56 (3.99)	747.03 (3.15)	773.21 (2.89)	799.87 (2.78)
140.00	649.46 (4.44)	687.63 (3.11)	702.24 (3.18)	730.33 (2.91)	757.83 (2.69)
160.00	604.89 (4.53)	644.33 (3.26)	660.00 (3.39)	687.50 (3.24)	716.14 (2.77)
180.00	557.36 (5.45)	599.43 (3.73)	614.96 (3.79)	645.67 (3.42)	678.87 (3.80)
200.00	522.16 (4.85)	565.66 (4.52)	582.56 (3.99)	613.84 (3.95)	642.66 (3.38)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 10. Average Maximum Power Current (mA/cm²)
After 10¹⁴ electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E14 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	50.00	100.00	135.30	250.00	500.00
-20.00	8.26 (.32)	16.72 (.61)	22.65 (.74)	41.71 (1.19)	84.79 (1.83)
.00	8.32 (.31)	16.84 (.55)	22.78 (.63)	42.07 (1.14)	85.36 (2.01)
20.00	8.31 (.31)	16.78 (.50)	22.89 (.62)	42.64 (1.21)	85.96 (2.00)
40.00	8.44 (.33)	17.18 (.76)	23.17 (.61)	42.71 (1.00)	86.36 (1.86)
60.00	8.44 (.24)	17.11 (.42)	23.24 (.46)	42.86 (1.02)	86.50 (2.19)
80.00	8.64 (.22)	17.31 (.40)	23.59 (.57)	43.14 (1.27)	86.46 (2.11)
100.00	8.57 (.26)	17.49 (.45)	23.81 (.56)	44.00 (1.19)	89.00 (2.65)
120.00	8.71 (.21)	17.61 (.44)	23.98 (.53)	44.36 (1.11)	89.21 (2.20)
140.00	8.51 (.26)	17.25 (.38)	23.52 (.65)	43.93 (.95)	88.25 (1.93)
160.00	8.52 (.19)	17.40 (.51)	24.02 (.56)	44.04 (1.20)	87.82 (2.23)
180.00	8.39 (.15)	17.21 (.41)	23.44 (.59)	44.11 (1.11)	90.04 (1.91)
200.00	8.38 (.28)	17.42 (.34)	23.59 (.66)	44.75 (1.01)	90.50 (2.48)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 11. Average Maximum Power Voltage (mV)
After 10^{14} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER $1.E14$ E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	830.86 (31.86)	871.29 (15.69)	888.57 (14.37)	909.57 (10.52)	913.00 (17.16)
.00	795.29 (20.62)	832.71 (13.80)	849.00 (10.65)	871.57 (7.52)	876.43 (14.41)
20.00	754.43 (21.28)	794.57 (11.46)	804.29 (6.42)	830.14 (6.52)	837.86 (13.42)
40.00	711.71 (15.05)	748.57 (10.16)	765.43 (6.90)	794.00 (7.05)	803.43 (9.05)
60.00	669.57 (11.24)	710.71 (8.58)	726.71 (7.74)	755.57 (4.24)	763.14 (7.20)
80.00	630.29 (13.35)	668.71 (7.76)	685.00 (5.97)	712.29 (7.50)	723.57 (7.44)
100.00	586.71 (8.48)	627.00 (6.83)	641.57 (5.68)	669.14 (6.18)	680.71 (5.12)
120.00	539.00 (10.63)	583.86 (6.23)	599.86 (4.41)	629.29 (7.63)	643.71 (7.45)
140.00	499.71 (6.75)	543.00 (4.55)	560.86 (3.67)	581.57 (2.99)	601.43 (5.56)
160.00	461.29 (7.97)	503.43 (5.47)	518.00 (3.96)	544.57 (4.43)	562.29 (7.52)
180.00	414.29 (8.67)	462.00 (3.56)	480.29 (4.75)	506.71 (4.50)	525.29 (5.65)
200.00	381.86 (8.49)	425.14 (7.01)	446.29 (5.59)	471.71 (2.43)	490.71 (10.39)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 12. Average Maximum Power (mW/cm²)
After 10¹⁴ electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E14 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	6.87 (.46)	14.57 (.67)	20.13 (.75)	37.94 (.93)	77.40 (1.51)
.00	6.62 (.38)	14.02 (.57)	19.34 (.62)	36.67 (.91)	74.80 (1.70)
20.00	6.27 (.35)	13.33 (.50)	18.41 (.53)	35.40 (.86)	72.02 (1.67)
40.00	6.01 (.30)	12.86 (.58)	17.74 (.45)	33.91 (.72)	69.38 (1.51)
60.00	5.65 (.24)	12.16 (.37)	16.89 (.47)	32.38 (.71)	66.00 (1.43)
80.00	5.44 (.21)	11.57 (.34)	16.16 (.37)	30.73 (.77)	62.56 (1.25)
100.00	5.03 (.18)	10.97 (.32)	15.27 (.34)	29.44 (.67)	60.58 (1.58)
120.00	4.70 (.16)	10.28 (.30)	14.39 (.33)	27.91 (.47)	57.42 (1.30)
140.00	4.25 (.15)	9.37 (.23)	13.19 (.36)	25.55 (.55)	53.07 (.98)
160.00	3.93 (.13)	8.76 (.25)	12.44 (.26)	23.98 (.60)	49.37 (1.07)
180.00	3.48 (.11)	7.95 (.21)	11.26 (.28)	22.35 (.48)	47.29 (.88)
200.00	3.20 (.10)	7.41 (.22)	10.52 (.25)	21.11 (.45)	44.39 (.91)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 13. Average Curve Factor
After 10^{14} electrons/cm²

HUGHES LPE GALS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER $1.E14$ E/CM ² TM-58					
CELL TEMP. (DEG. C)	50.00	100.00	135.30	250.00	500.00
-20.00	.7477 (.0395)	.7728 (.0270)	.7795 (.0222)	.7832 (.0109)	.7766 (.0154)
.00	.7465 (.0333)	.7680 (.0219)	.7748 (.0159)	.7779 (.0115)	.7718 (.0140)
20.00	.7363 (.0314)	.7587 (.0180)	.7632 (.0126)	.7720 (.0083)	.7691 (.0106)
40.00	.7258 (.0256)	.7535 (.0216)	.7566 (.0135)	.7653 (.0072)	.7600 (.0086)
60.00	.7128 (.0217)	.7393 (.0145)	.7472 (.0108)	.7550 (.0059)	.7479 (.0103)
80.00	.6979 (.0193)	.7194 (.0124)	.7308 (.0086)	.7373 (.0040)	.7339 (.0094)
100.00	.6816 (.0156)	.7083 (.0107)	.7155 (.0081)	.7235 (.0052)	.7208 (.0082)
120.00	.6659 (.0164)	.6933 (.0090)	.7011 (.0055)	.7148 (.0046)	.7059 (.0111)
140.00	.6490 (.0148)	.6762 (.0082)	.6885 (.0087)	.6925 (.0046)	.6915 (.0095)
160.00	.6264 (.0140)	.6564 (.0088)	.6678 (.0076)	.6812 (.0065)	.6752 (.0095)
180.00	.5980 (.0126)	.6368 (.0064)	.6481 (.0075)	.6615 (.0069)	.6619 (.0125)
200.00	.5665 (.0099)	.6083 (.0084)	.6217 (.0078)	.6426 (.0073)	.6463 (.0141)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 14. Average AMO Efficiency (Percent)
After 10^{14} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E14 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	13.74 (.92)	14.57 (.67)	14.88 (.55)	15.17 (.37)	15.48 (.30)
.00	13.25 (.75)	14.02 (.57)	14.30 (.46)	14.67 (.37)	14.96 (.34)
20.00	12.55 (.71)	13.33 (.50)	13.61 (.39)	14.16 (.34)	14.40 (.33)
40.00	12.01 (.59)	12.86 (.58)	13.11 (.33)	13.57 (.29)	13.88 (.30)
60.00	11.30 (.47)	12.15 (.37)	12.49 (.35)	12.95 (.28)	13.20 (.29)
80.00	10.89 (.42)	11.57 (.34)	11.94 (.27)	12.29 (.31)	12.51 (.25)
100.00	10.05 (.35)	10.97 (.32)	11.29 (.25)	11.78 (.27)	12.12 (.32)
120.00	9.39 (.33)	10.28 (.30)	10.63 (.24)	11.16 (.19)	11.48 (.26)
140.00	8.51 (.29)	9.37 (.23)	9.75 (.26)	10.22 (.22)	10.61 (.20)
160.00	7.86 (.27)	8.76 (.25)	9.19 (.19)	9.59 (.24)	9.87 (.21)
180.00	6.95 (.23)	7.95 (.21)	8.32 (.21)	8.94 (.19)	9.46 (.18)
200.00	6.40 (.20)	7.41 (.22)	7.78 (.19)	8.44 (.18)	8.88 (.18)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 15. Average Short Circuit Current (mA/cm^2)
After 10^{15} electrons/ cm^2

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER $1.E15$ E/ CM^2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM^2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	8.02 (.18)	16.29 (.39)	22.02 (.55)	39.76 (.83)	82.12 (3.22)
.00	8.19 (.21)	16.48 (.39)	22.28 (.54)	41.20 (1.10)	83.85 (2.34)
20.00	8.26 (.18)	16.60 (.46)	22.51 (.59)	41.65 (1.01)	85.45 (2.21)
40.00	8.41 (.20)	16.91 (.43)	22.74 (.57)	42.13 (1.16)	85.27 (2.34)
60.00	8.64 (.20)	17.21 (.48)	23.21 (.57)	42.44 (1.06)	86.35 (2.47)
80.00	8.75 (.20)	17.41 (.44)	23.76 (.60)	43.57 (1.09)	87.88 (2.25)
100.00	8.81 (.19)	17.75 (.44)	24.12 (.57)	44.01 (1.03)	89.29 (2.62)
120.00	9.02 (.21)	18.02 (.43)	24.49 (.58)	45.51 (1.15)	90.94 (2.79)
140.00	9.18 (.21)	18.63 (.45)	24.57 (.57)	45.84 (1.09)	91.82 (2.39)
160.00	9.32 (.20)	18.72 (.46)	25.29 (.60)	46.37 (1.15)	93.60 (2.49)
180.00	9.49 (.20)	19.16 (.51)	25.75 (.61)	47.20 (1.06)	95.57 (2.26)
200.00	9.68 (.21)	19.58 (.53)	26.37 (.60)	48.45 (1.15)	96.85 (2.38)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 16. Average Open Circuit Voltage (mV)
After 10^{15} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E15 E/CM ² TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM ²)				
	50.00	100.00	135.30	250.00	500.00
-20.00	954.06 (3.28)	977.60 (2.48)	987.00 (2.15)	1004.56 (1.95)	1024.71 (2.91)
.00	913.44 (3.10)	937.89 (2.15)	947.31 (2.17)	966.30 (2.12)	987.83 (2.03)
20.00	871.64 (2.92)	896.57 (2.68)	906.54 (2.43)	927.43 (2.28)	948.83 (2.43)
40.00	828.60 (3.16)	855.96 (2.58)	865.27 (2.14)	886.47 (2.40)	909.39 (2.64)
60.00	784.60 (3.11)	812.61 (2.61)	824.01 (2.41)	845.79 (2.73)	868.91 (2.46)
80.00	739.96 (3.22)	769.39 (2.75)	781.24 (3.22)	804.39 (2.75)	829.17 (3.15)
100.00	694.47 (3.63)	725.90 (3.16)	738.73 (3.03)	761.63 (2.92)	787.60 (2.87)
120.00	648.89 (3.52)	682.13 (3.07)	694.30 (3.27)	719.14 (3.23)	747.69 (4.04)
140.00	602.27 (4.00)	637.13 (3.47)	649.81 (3.31)	676.30 (3.20)	703.59 (3.06)
160.00	554.50 (3.93)	590.16 (3.37)	605.46 (3.05)	632.87 (3.38)	663.40 (3.47)
180.00	510.19 (3.70)	546.56 (4.65)	562.83 (3.12)	591.36 (3.31)	619.83 (3.22)
200.00	463.44 (4.28)	505.39 (4.15)	518.41 (3.28)	552.26 (4.00)	584.80 (3.88)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 17. Average Maximum Power Current (mA/cm²)
After 10¹⁵ electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E15 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	7.03 (.50)	14.64 (.47)	20.10 (.60)	36.32 (.79)	75.39 (3.10)
.00	7.26 (.28)	14.93 (.44)	20.26 (.60)	37.64 (1.15)	77.14 (2.13)
20.00	7.29 (.28)	14.91 (.50)	20.45 (.71)	37.79 (.83)	78.07 (2.07)
40.00	7.44 (.28)	15.16 (.52)	20.51 (.64)	37.79 (.83)	77.25 (2.14)
60.00	7.60 (.25)	15.40 (.47)	20.96 (.59)	38.29 (1.09)	77.79 (2.28)
80.00	7.69 (.22)	15.41 (.42)	21.26 (.52)	38.96 (1.11)	78.86 (2.15)
100.00	7.63 (.23)	15.56 (.44)	21.37 (.62)	39.14 (.90)	79.96 (2.32)
120.00	7.72 (.23)	15.91 (.44)	21.38 (.32)	40.11 (1.01)	80.50 (2.64)
140.00	7.77 (.24)	16.02 (.44)	21.29 (.63)	40.11 (1.01)	80.32 (2.27)
160.00	7.74 (.20)	15.86 (.33)	21.69 (.50)	40.00 (1.07)	81.39 (2.08)
180.00	7.66 (.17)	16.01 (.49)	21.61 (.59)	39.96 (.86)	81.71 (1.85)
200.00	7.56 (.13)	15.87 (.55)	21.65 (.47)	40.68 (.93)	82.39 (2.22)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 18. Average Maximum Power Voltage (mV)
After 10^{15} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E15 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	818.14 (9.03)	853.86 (4.56)	859.57 (2.44)	875.57 (3.54)	872.86 (18.94)
.00	781.43 (9.22)	814.14 (4.53)	819.29 (3.73)	835.14 (10.78)	837.29 (14.03)
20.00	745.00 (8.43)	770.14 (6.04)	777.86 (2.67)	798.14 (3.63)	797.43 (8.64)
40.00	696.71 (5.99)	730.14 (3.98)	739.43 (2.64)	757.86 (3.63)	767.14 (11.60)
60.00	655.00 (6.38)	680.71 (1.38)	691.14 (4.53)	713.14 (7.22)	723.57 (6.95)
80.00	602.86 (4.22)	639.43 (2.94)	648.86 (6.04)	670.71 (3.15)	684.00 (7.39)
100.00	557.57 (3.95)	596.57 (2.23)	606.86 (6.20)	623.71 (3.95)	636.86 (3.58)
120.00	519.86 (5.79)	548.14 (7.27)	562.86 (2.34)	580.14 (1.46)	598.43 (4.79)
140.00	473.00 (4.73)	511.71 (4.11)	521.43 (4.35)	544.71 (4.11)	556.43 (4.86)
160.00	424.43 (4.12)	464.43 (4.69)	477.00 (4.47)	503.71 (3.09)	517.57 (2.23)
180.00	384.71 (5.79)	418.57 (3.31)	437.29 (7.06)	462.00 (2.58)	474.43 (5.74)
200.00	342.57 (6.19)	383.00 (4.12)	394.86 (3.67)	418.57 (4.31)	435.43 (5.00)
NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.					

Table 19. Average Maximum Power (mW/cm²)
After 10¹⁵ electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E15 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	5.75 (.42)	12.50 (.38)	17.28 (.49)	31.80 (.65)	65.78 (2.32)
.00	5.68 (.27)	12.15 (.39)	16.60 (.49)	31.43 (.79)	64.59 (1.84)
20.00	5.43 (.25)	11.48 (.40)	15.90 (.53)	30.16 (.72)	62.25 (1.49)
40.00	5.19 (.22)	11.07 (.37)	15.16 (.46)	28.64 (.61)	59.26 (1.67)
60.00	4.98 (.19)	10.48 (.34)	14.49 (.40)	27.30 (.77)	56.28 (1.51)
80.00	4.64 (.16)	9.86 (.27)	13.80 (.40)	26.13 (.71)	53.93 (1.41)
100.00	4.26 (.14)	9.28 (.24)	12.97 (.32)	24.41 (.48)	50.92 (1.41)
120.00	4.01 (.14)	8.72 (.24)	12.03 (.17)	23.27 (.63)	48.17 (1.31)
140.00	3.68 (.13)	8.20 (.23)	11.10 (.28)	21.85 (.57)	44.69 (1.14)
160.00	3.28 (.10)	7.36 (.19)	10.35 (.24)	20.15 (.51)	42.13 (1.09)
180.00	2.95 (.10)	6.70 (.22)	9.45 (.23)	18.46 (.34)	38.77 (.88)
200.00	2.59 (.08)	6.08 (.21)	8.55 (.20)	17.03 (.35)	35.87 (.79)
NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.					

Table 20. Average Curve Factor
After 10^{15} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E15 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	.7510 (.0500)	.7847 (.0147)	.7949 (.0081)	.7961 (.0057)	.7820 (.0171)
.00	.7586 (.0239)	.7864 (.0147)	.7865 (.0082)	.7895 (.0063)	.7799 (.0173)
20.00	.7539 (.0263)	.7714 (.0136)	.7791 (.0100)	.7807 (.0062)	.7679 (.0114)
40.00	.7441 (.0226)	.7645 (.0105)	.7706 (.0092)	.7670 (.0135)	.7642 (.0146)
60.00	.7344 (.0188)	.7494 (.0101)	.7575 (.0063)	.7605 (.0069)	.7502 (.0078)
80.00	.7167 (.0168)	.7358 (.0103)	.7433 (.0086)	.7457 (.0038)	.7402 (.0105)
100.00	.6952 (.0147)	.7203 (.0085)	.7276 (.0099)	.7284 (.0069)	.7242 (.0077)
120.00	.6854 (.0143)	.7093 (.0073)	.7080 (.0158)	.7109 (.0041)	.7084 (.0074)
140.00	.6653 (.0147)	.6907 (.0066)	.6952 (.0050)	.7048 (.0043)	.6918 (.0090)
160.00	.6350 (.0105)	.6665 (.0063)	.6759 (.0079)	.6866 (.0042)	.6785 (.0093)
180.00	.6091 (.0106)	.6399 (.0048)	.6520 (.0073)	.6615 (.0068)	.6545 (.0097)
200.00	.5770 (.0103)	.6140 (.0055)	.6255 (.0048)	.6364 (.0060)	.6335 (.0111)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 21. Average AMO Efficiency (Percent)
After 10^{15} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E15 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	50.00	SOLAR INTENSITY (MW/CM**2)			500.00
		100.00	135.30	250.00	
-20.00	11.50 (.84)	12.50 (.38)	12.77 (.36)	12.72 (.26)	13.16 (.46)
.00	11.36 (.55)	12.15 (.39)	12.27 (.36)	12.57 (.32)	12.92 (.37)
20.00	10.86 (.50)	11.48 (.40)	11.75 (.39)	12.06 (.29)	12.45 (.30)
40.00	10.37 (.44)	11.07 (.37)	11.21 (.34)	11.45 (.25)	11.85 (.33)
60.00	9.96 (.38)	10.48 (.34)	10.71 (.29)	10.92 (.31)	11.26 (.30)
80.00	9.28 (.31)	9.86 (.27)	10.20 (.29)	10.45 (.28)	10.79 (.28)
100.00	8.51 (.29)	9.28 (.24)	9.58 (.24)	9.76 (.19)	10.18 (.28)
120.00	8.03 (.29)	8.72 (.24)	8.89 (.12)	9.31 (.25)	9.63 (.26)
140.00	7.36 (.27)	8.20 (.23)	8.20 (.21)	8.74 (.23)	8.94 (.23)
160.00	6.57 (.21)	7.36 (.19)	7.65 (.18)	8.06 (.20)	8.43 (.22)
180.00	5.90 (.20)	6.70 (.22)	6.98 (.17)	7.38 (.13)	7.75 (.18)
200.00	5.18 (.16)	6.08 (.21)	6.32 (.15)	6.81 (.14)	7.17 (.16)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 22. Average Short Circuit Current (mA/cm²)
After 10¹⁶ electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E16 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	5.77 (.30)	11.53 (.59)	15.58 (.79)	28.68 (1.45)	57.84 (3.31)
.00	5.89 (.27)	11.76 (.59)	15.86 (.79)	29.25 (1.45)	58.85 (3.16)
20.00	5.97 (.29)	12.01 (.65)	16.14 (.79)	30.14 (1.56)	59.64 (3.08)
40.00	6.19 (.30)	12.32 (.63)	16.57 (.82)	31.87 (4.11)	61.50 (3.23)
60.00	6.30 (.32)	12.58 (.61)	16.98 (.85)	31.41 (1.59)	63.23 (3.17)
80.00	6.51 (.30)	13.04 (.67)	17.69 (.83)	32.25 (1.61)	64.68 (3.26)
100.00	6.67 (.32)	13.25 (.64)	17.92 (.85)	32.82 (1.53)	66.10 (3.56)
120.00	6.85 (.30)	13.77 (.68)	18.61 (.84)	33.84 (1.56)	67.54 (3.57)
140.00	7.03 (.31)	14.11 (.63)	19.04 (.87)	35.14 (1.61)	70.76 (3.53)
160.00	7.34 (.31)	14.75 (.71)	19.76 (.81)	36.21 (1.60)	72.58 (3.38)
180.00	7.55 (.32)	15.06 (.63)	20.35 (.87)	37.61 (1.69)	76.32 (3.44)
200.00	8.07 (.32)	16.17 (.69)	21.97 (.90)	39.09 (1.69)	77.51 (3.58)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 23. Average Open Circuit Voltage (mV)
After 10^{16} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E16 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	869.09 (57.59)	903.94 (21.85)	915.04 (14.75)	934.71 (8.79)	955.24 (5.98)
.00	828.01 (45.86)	860.87 (19.40)	872.37 (13.27)	892.66 (8.27)	913.80 (5.60)
20.00	785.64 (36.16)	817.53 (16.26)	828.91 (12.05)	850.96 (7.96)	873.41 (5.92)
40.00	742.57 (28.22)	772.87 (14.10)	786.99 (11.50)	807.51 (7.45)	831.89 (6.22)
60.00	697.34 (23.37)	728.31 (12.82)	741.16 (10.38)	765.24 (7.80)	790.47 (6.05)
80.00	650.83 (19.00)	683.69 (11.71)	697.24 (9.80)	720.94 (8.03)	747.71 (6.30)
100.00	600.89 (16.93)	636.26 (10.88)	649.34 (9.65)	676.21 (7.67)	704.16 (6.48)
120.00	555.77 (13.76)	591.59 (9.28)	605.29 (8.90)	631.17 (7.51)	659.50 (6.99)
140.00	507.74 (12.30)	545.13 (9.26)	559.16 (8.63)	588.14 (7.80)	618.06 (7.50)
160.00	462.79 (10.23)	501.33 (8.46)	515.61 (7.71)	543.26 (7.33)	571.90 (7.34)
180.00	412.79 (9.65)	452.30 (8.37)	467.93 (7.12)	499.77 (6.66)	531.04 (6.00)
200.00	380.19 (10.64)	417.17 (7.71)	433.41 (7.29)	458.49 (7.49)	486.99 (5.92)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 24. Average Maximum Power Current (mA/cm²)
After 10¹⁶ electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E16 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	4.92 (.41)	10.04 (.86)	13.67 (1.09)	24.95 (1.95)	51.07 (3.87)
.00	5.06 (.39)	10.32 (.75)	13.97 (1.01)	25.76 (2.05)	52.07 (3.69)
20.00	5.21 (.35)	10.52 (.85)	14.12 (1.10)	26.68 (1.95)	52.68 (3.48)
40.00	5.30 (.47)	10.70 (.83)	14.45 (1.10)	26.82 (1.95)	54.46 (3.51)
60.00	5.39 (.44)	10.99 (.75)	14.85 (1.03)	27.71 (1.87)	55.86 (3.41)
80.00	5.58 (.41)	11.33 (.74)	15.52 (1.00)	28.25 (1.69)	56.64 (3.00)
100.00	5.63 (.42)	11.38 (.69)	15.49 (.96)	28.65 (1.67)	57.64 (3.44)
120.00	5.71 (.36)	11.75 (.75)	15.97 (.87)	29.24 (1.34)	58.61 (3.27)
140.00	5.81 (.34)	11.93 (.68)	16.21 (.86)	30.04 (1.63)	60.89 (3.24)
160.00	5.94 (.31)	12.25 (.65)	16.52 (.71)	30.69 (1.43)	61.00 (3.24)
180.00	5.96 (.32)	12.20 (.61)	16.81 (.96)	31.24 (1.74)	63.71 (2.76)
200.00	6.25 (.34)	12.89 (.51)	17.59 (.70)	31.87 (1.30)	63.18 (2.61)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 25. Average Maximum Power Voltage (mV)
After 10^{16} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER $1.E16$ E/CM**2 TM-58					
CELL TEMP. (DEG. C)	50.00	100.00	135.30	250.00	500.00
-20.00	736.29 (111.41)	767.71 (83.25)	779.57 (71.46)	804.86 (38.86)	817.86 (16.08)
.00	692.86 (92.82)	728.43 (73.49)	738.71 (60.40)	767.57 (25.68)	781.43 (14.52)
20.00	649.00 (74.68)	682.43 (55.52)	687.43 (53.23)	724.29 (23.75)	743.00 (13.50)
40.00	611.14 (58.58)	643.14 (40.38)	659.00 (34.76)	682.57 (14.46)	695.86 (9.44)
60.00	565.14 (49.30)	596.00 (34.86)	612.29 (26.41)	634.71 (14.65)	652.86 (9.21)
80.00	519.43 (37.68)	557.00 (24.33)	566.29 (20.56)	592.14 (14.57)	610.86 (9.17)
100.00	474.57 (26.71)	511.43 (20.08)	524.00 (14.54)	546.86 (8.41)	566.86 (5.18)
120.00	431.29 (19.59)	466.43 (15.99)	479.43 (13.65)	504.29 (11.41)	522.29 (3.95)
140.00	385.57 (16.68)	422.86 (9.62)	433.71 (10.59)	462.86 (9.41)	480.71 (6.58)
160.00	344.57 (12.71)	382.57 (9.41)	394.86 (9.46)	417.14 (8.43)	438.00 (4.58)
180.00	299.86 (12.29)	338.57 (10.36)	351.29 (8.56)	376.86 (5.08)	394.14 (4.53)
200.00	271.86 (11.08)	306.14 (9.67)	320.14 (8.40)	337.14 (7.38)	352.71 (4.23)
NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.					

Table 26. Average Maximum Power ($\mu\text{W}/\text{cm}^2$)
After 10^{16} electrons/ cm^2

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E16 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM**2)				
	50.00	100.00	135.30	250.00	500.00
-20.00	3.65 (.72)	7.75 (1.29)	10.71 (1.59)	20.13 (2.28)	41.77 (3.27)
.00	3.53 (.65)	7.55 (1.14)	10.36 (1.41)	19.81 (2.06)	40.69 (3.01)
20.00	3.39 (.51)	7.21 (1.05)	9.74 (1.34)	19.35 (1.81)	39.14 (2.73)
40.00	3.25 (.53)	6.90 (.87)	9.55 (1.10)	18.32 (1.56)	37.90 (2.55)
60.00	3.06 (.46)	6.56 (.75)	9.11 (.94)	17.60 (1.41)	36.47 (2.26)
80.00	2.91 (.38)	6.32 (.65)	8.80 (.81)	16.74 (1.24)	34.60 (1.94)
100.00	2.68 (.32)	5.83 (.54)	8.13 (.69)	15.68 (1.06)	32.68 (1.99)
120.00	2.47 (.25)	5.49 (.48)	7.67 (.58)	14.75 (.93)	30.61 (1.76)
140.00	2.24 (.21)	5.05 (.37)	7.04 (.49)	13.91 (.88)	29.27 (1.53)
160.00	2.05 (.17)	4.69 (.35)	6.53 (.40)	12.81 (.74)	26.72 (1.45)
180.00	1.79 (.16)	4.13 (.29)	5.91 (.42)	11.78 (.71)	25.12 (1.25)
200.00	1.70 (.15)	3.95 (.26)	5.63 (.34)	10.75 (.63)	22.29 (1.01)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 27. Average Curve Factor
After 10^{16} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1.E16 E/CM**2 TM-58					
CELL TEMP. (DEG. C)	50.00	100.00	135.30	250.00	500.00
-20.00	.7200 (.0941)	.7406 (.0956)	.7490 (.0891)	.7500 (.0650)	.7560 (.0399)
.00	.7182 (.0922)	.7430 (.0888)	.7473 (.0815)	.7577 (.0598)	.7566 (.0335)
20.00	.7191 (.0665)	.7326 (.0793)	.7262 (.0753)	.7538 (.0485)	.7512 (.0264)
40.00	.7046 (.0820)	.7231 (.0668)	.7310 (.0603)	.7181 (.0774)	.7406 (.0217)
60.00	.6942 (.0707)	.7150 (.0556)	.7226 (.0497)	.7317 (.0320)	.7294 (.0182)
80.00	.6846 (.0580)	.7082 (.0447)	.7125 (.0387)	.7194 (.0265)	.7154 (.0150)
100.00	.6670 (.0467)	.6906 (.0367)	.6976 (.0315)	.7058 (.0201)	.7020 (.0123)
120.00	.6461 (.0358)	.6728 (.0296)	.6800 (.0238)	.6904 (.0171)	.6872 (.0076)
140.00	.6271 (.0321)	.6558 (.0193)	.6605 (.0187)	.6725 (.0139)	.6693 (.0116)
160.00	.6021 (.0211)	.6339 (.0191)	.6405 (.0143)	.6508 (.0104)	.6435 (.0073)
180.00	.5731 (.0221)	.6060 (.0143)	.6205 (.0333)	.6261 (.0064)	.6197 (.0118)
200.00	.5538 (.0213)	.5849 (.0106)	.5914 (.0115)	.5995 (.0073)	.5905 (.0086)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

Table 28. Average AMO Efficiency (Percent)
After 10^{16} electrons/cm²

HUGHES LPE GAAS CELLS (9/79) P/N JUNCTION .LE. 0.5 MICRONS WINDOW .LE. 0.5 MICRONS 2X2X.0305 CM (SAMPLE SIZE 7) CONTACTS FRONT: (NI GE AU)/AG REAR: AU-ZN/AG TA205 A-R. 7940 COVER .03 CM AFTER 1-E16 E/CM ² TM-58					
CELL TEMP. (DEG. C)	SOLAR INTENSITY (MW/CM ²)				
	50.00	100.00	135.30	250.00	500.00
-20.00	7.29 (1.44)	7.75 (1.29)	7.91 (1.18)	8.05 (.91)	8.35 (.65)
.00	7.06 (1.30)	7.55 (1.14)	7.66 (1.04)	7.92 (.83)	8.14 (.60)
20.00	6.78 (1.01)	7.21 (1.05)	7.20 (.99)	7.74 (.73)	7.83 (.55)
40.00	6.51 (1.06)	6.90 (.87)	7.06 (.81)	7.33 (.62)	7.58 (.51)
60.00	6.12 (.91)	6.56 (.75)	6.73 (.70)	7.04 (.56)	7.29 (.45)
80.00	5.82 (.76)	6.32 (.65)	6.50 (.60)	6.70 (.50)	6.92 (.39)
100.00	5.36 (.64)	5.83 (.54)	6.01 (.51)	6.27 (.42)	6.54 (.40)
120.00	4.93 (.50)	5.49 (.48)	5.67 (.43)	5.90 (.37)	6.12 (.35)
140.00	4.49 (.43)	5.05 (.37)	5.20 (.36)	5.56 (.35)	5.85 (.31)
160.00	4.10 (.34)	4.69 (.35)	4.83 (.30)	5.12 (.30)	5.34 (.29)
180.00	3.58 (.32)	4.13 (.29)	4.37 (.31)	4.71 (.28)	5.00 (.25)
200.00	3.40 (.29)	3.95 (.26)	4.16 (.25)	4.30 (.25)	4.46 (.20)

NOTE: STANDARD DEVIATIONS ARE GIVEN IN PARENTHESES.

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BLACK AND WHITE PHOTOGRAPH

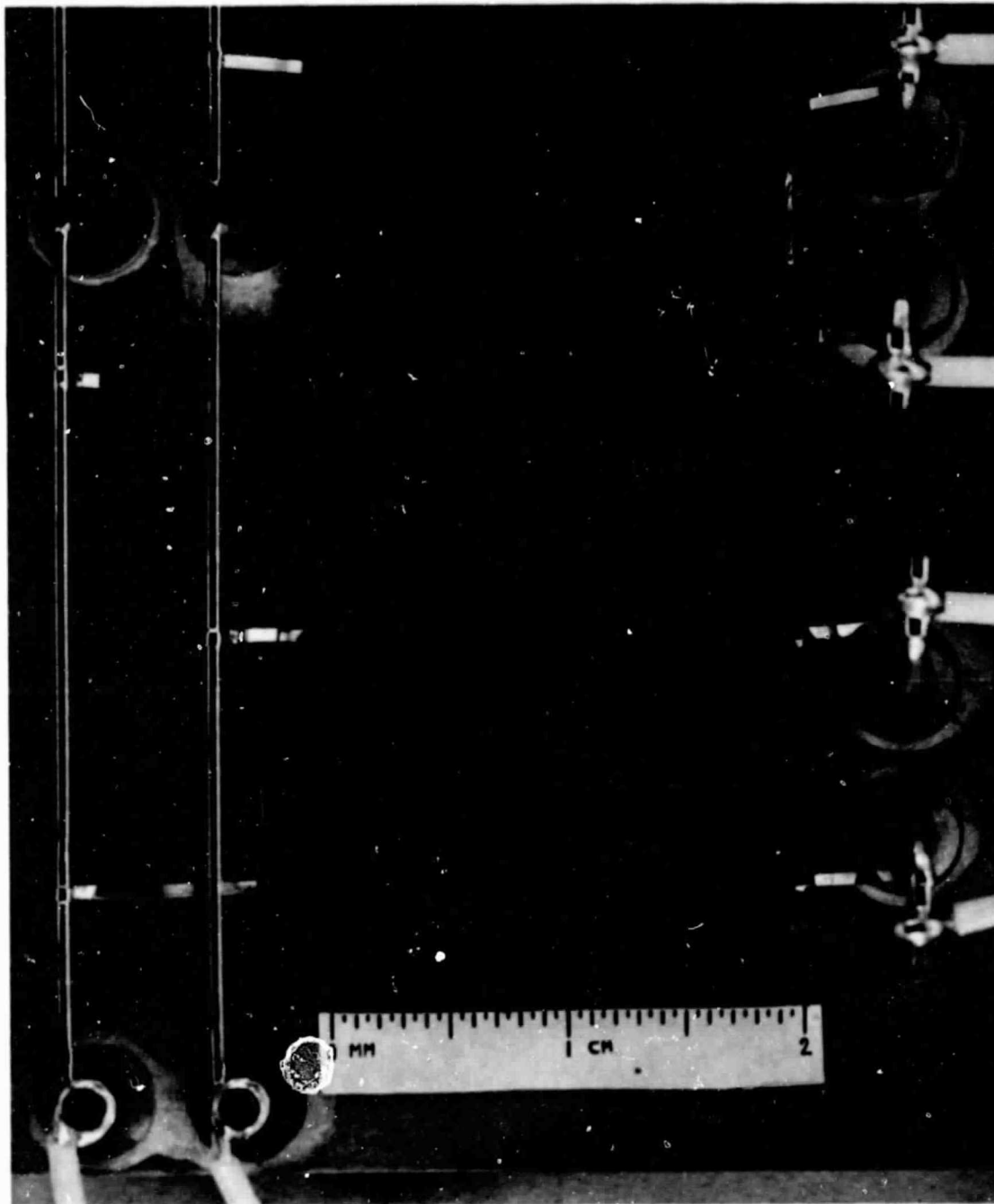


Figure A-1. Solar Cell

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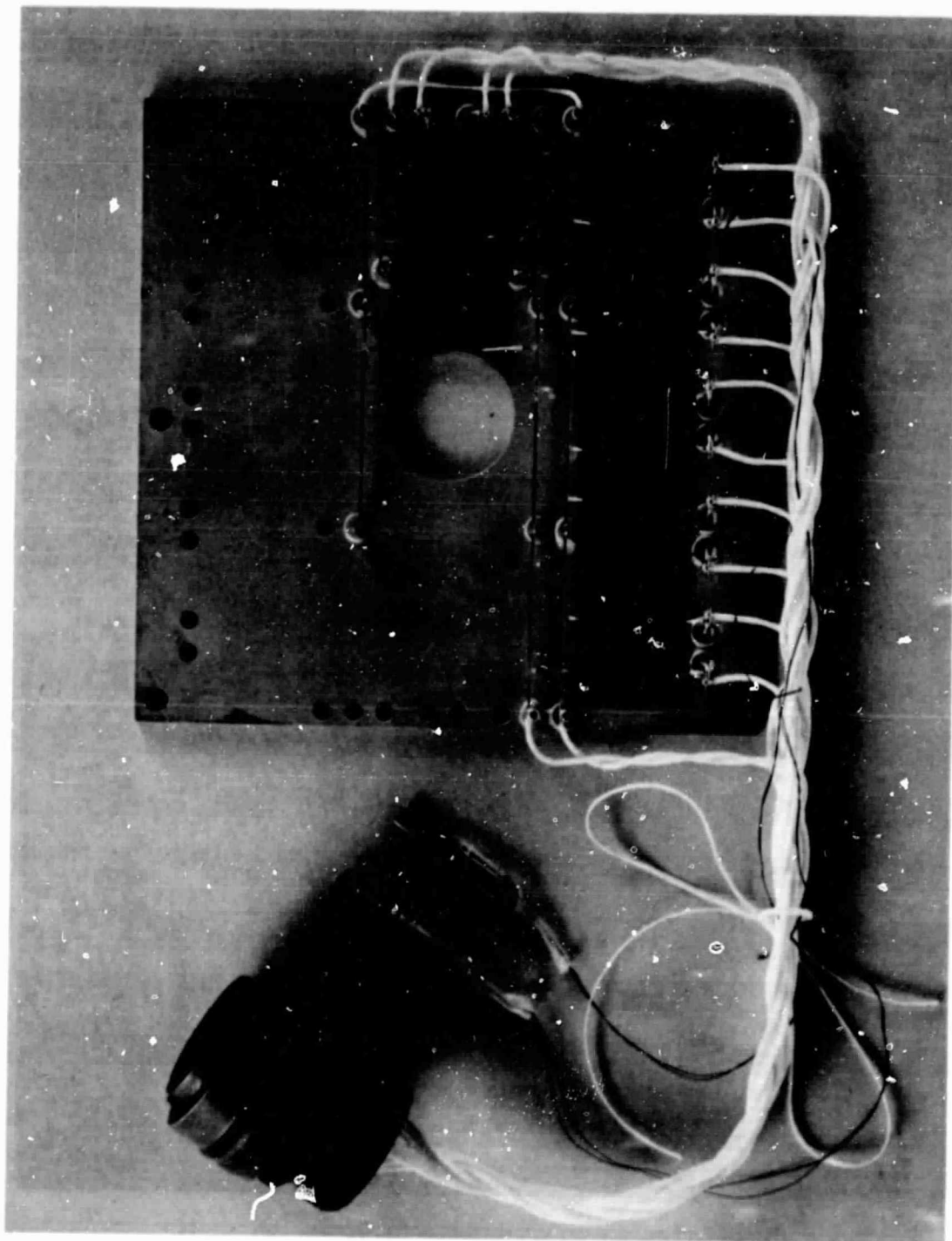


Figure A-2. Test Plate

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Figure A-3. Solar Cell Characterization Facility

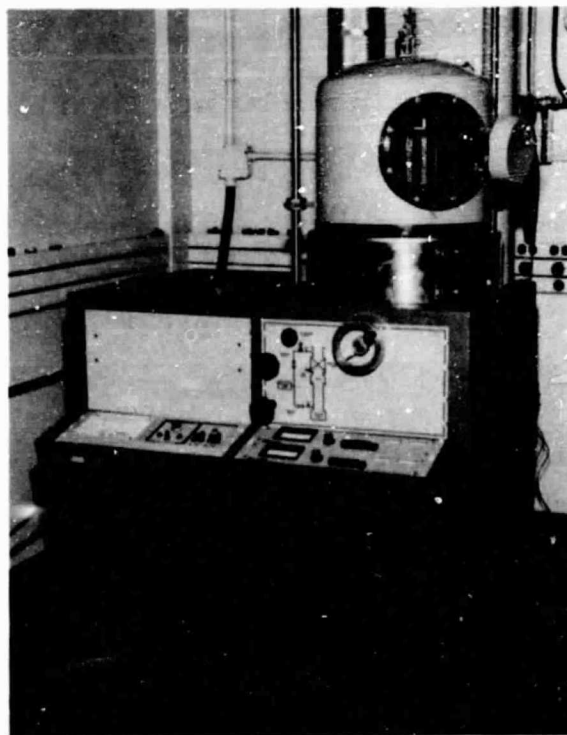


Figure A-4. Solar Cell Environmental Test Chamber